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Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in rural areas

Koen Salemink [a, *], Dirk Strijker [a], Gary Bosworth [b]

[a] Cultural Geography Department, Faculty of Spatial Sciences, University of Groningen, PO Box 800, 9700 AV Groningen, The Netherlands
[b] University of Lincoln, Lincoln Business School, Brayford Pool, Lincoln LN6 7TS, UK

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ABSTRACT

This paper presents a systematic review of 157 papers on digital developments and rural development in advanced countries. It focuses on the general conclusions, in order to better understand the potential impacts of the coming Next Generation Access revolution. We distinguish two major strands of research: connectivity research and inclusion research. In the connectivity theme, the conclusion is that there are persistent and growing differences in data infrastructure quality between urban and rural areas. Public policies to promote the availability or improvement of data infrastructure are essentially responsive, and rapidly outdated by market developments. For inclusion, the hampered diffusion of technologies, and the lower average levels of education and skills in rural areas have a negative impact on adoption and use. Generic policies in this field neglect specific local needs. The paradox is that rural communities are most in need of improved digital connectivity to compensate for their remoteness, but they are least connected and included. Future research should therefore focus on specific places and communities – combining both connectivity and inclusion issues – in order to inform 'customized policies' for poorly connected and digitally excluded rural communities.

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1. Introduction

Rural communities have been struggling to keep up with developments in digital connectivity (Malecki, 2003; Strover, 2003; Velaga et al., 2012). At the end of the twentieth century, a great deal of governmental and market effort was expended in advanced western societies in order to upgrade rural telephone networks for use by the Internet (Cambini and Jiang, 2009; Holt and Galligan, 2013). This undertaking was founded on the idea that all regions and communities should have access to the Internet in order to prevent growing regional disparities (see for example Cornford and Gillespie, 1993). Telephony was regarded as a utility, which ensured that (state) companies would invest in rural networks as well. Upgrading these networks for Internet use followed a similar track (Malecki, 2003; Cambini and Jiang, 2009).

Today, accessing the Internet through telephone lines is only one of several technologies available. Cable Internet, fiber optics, and mobile broadband are now all widely available, except in rural areas (Whitacre and Mills, 2010; Townsend et al., 2013). More recent technologies which go beyond telephone lines have not (yet) been regarded as utilities, so governments have not been able to promote their universal provision in the same way, and considerable investments are needed if this is to change (Ragoobar et al., 2011). Furthermore, in terms of speed and reliability, these forms of Next Generation Access (NGA) are now rapidly developing in the areas where they are already available. Differences between the well-served, largely urban areas and the underserved, mainly rural areas are therefore growing, resulting in a spatial digital divide (Townsend et al., 2013). Malecki (2003) positions the lack of availability of, and thus access to, data infrastructure and its high costs in the broader context of a general lack of service provision in rural areas as compared to urban areas. Malecki (2003: 201) frames this as 'the rural penalty' (see also Hite, 1997), meaning that people in rural areas 'pay a price' for living in remote areas, which affects many different economic sectors and social groups (Woods, 2005; Bosworth, 2010; Velaga et al., 2012; Stockdale and MacLeod, 2013).

However, it is not just the technologies that are rapidly changing. In addition to the material issues that rural communities face in the digital age, there are also issues of a social nature. The adoption and use of the Internet and associated applications are becoming increasingly diverse, and digital inclusion is no longer regarded as a

* Corresponding author.
E-mail address: k.salemink@rug.nl (K. Salemink).

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binary issue. In other words, the debate is no longer about 'haves' and 'have nots' (Kilpeläinen and Seppänen, 2014; Mariën and Prodnik, 2014); instead, it has started to focus on the degree of usage and different usage patterns. There is increasing recognition of the complexity of digital inclusion (see also Gilbert, 2010; Helsper, 2012). In order to understand the impact of digital connectivity, one must also understand the actual usage. Providing the connectivity and technology is just one aspect of keeping up with developments; adoption and actual usage are the next steps that need to be taken in order for digital connectivity to have an impact (Hage et al., 2013).

Since the introduction of the Internet to the consumer market, researchers from various disciplines have shown interest in the causes and consequences of this urban-rural divide, resulting in a large and growing body of literature. However, the topical issues for rural development are commonly discussed within (sub)disciplines, resulting in a somewhat fragmented debate. This paper will therefore adopt a transdisciplinary approach in order to provide a timely overview of the research in this field so far, with a focus on advanced western countries. For comparability reasons, we will only include the literature on these countries. The impact of ICT developments in rural areas will never be identical, but, by excluding the literature on developing and transitional countries, the differences in development trajectories are minimized. This overview has been created through a systematic literature review, based on key themes drawn from the debates on digital developments in relation to rural development.

Two questions are addressed by this systematic literature review: 1) What general insights and conclusions can we extract from previous research on rural areas in the age of digitalization? 2) How can these contribute to setting a new research agenda for better understanding the impacts of rapid technological developments? By answering these questions, we will contribute to the future research agenda, and we will provide recommendations for future policy in order to contribute towards bridging the spatial digital divide between the urban and the rural.

The outline of the paper is as follows. Section 2 provides a background on digital rural development, based on a pilot literature review. In section 3, the outline of the systematic search and review is discussed. Sections 4 and 5 discuss the observations and conclusions of the selected papers as to the role of ICTs in rural development, and we will end by summarizing these in terms of an overview of the field. Section 6 presents the overall conclusions and its implications, and it proposes a future agenda for research and policy.

2. Towards a framework for a systematic literature review

Generally, the literature in this field has shown that – in order to actively take part in a digitalizing information society – data infrastructures such as DSL, cable (coax), fiber optics, or mobile broadband need to be available at a reasonable price. However, lower densities and greater distances in rural areas discourage the market from investing in new technologies (Malecki, 2003). More recent literature suggests that rural areas are increasingly found at the wrong end of a 'digital divide' (Skerratt et al., 2012; Townsend et al., 2013). Urban areas are the digital 'hot spots' where high-speed Internet infrastructure is ubiquitous, while rural areas tend to be dependent on low-tech Internet access, with lower speeds and less reliable connections (Skerratt, 2010; Skerratt et al., 2012). This was the case with cable Internet access, which in the Netherlands for example, was never deployed in rural areas outside the curtilage of villages (Nucciarelli et al., 2010). Currently, history is repeating itself with other so-called Next Generation Access networks (NGA) such as fiber optics (Townsend et al., 2013). The market is assumed to deliver these NGA's to high-density urban areas eventually – even though some urban premises are still awaiting this delivery (see for example Ofcom, 2014). This is, however, less straightforward for rural areas, in which the backbone infrastructure is often still inadequate (European Commission, 2013). In its regulatory framework, the EU defines three categories of market areas: fully served 'black areas' with market competition, less served 'grey areas' with at least one provider but limited competition, and underserved 'white areas' without market competition (Sadowski et al., 2009; European Commission, 2013). Rural areas are mostly white areas, or grey at best. Even though government support is legally permitted in white and grey areas, this has not resulted in improved digital connectivity in European rural areas (Sadowski et al., 2009: 585).

Research into disparities in digital development often departs from the context of the network society, using the seminal work of Castells (2000) as a starting point. Urban and rural areas are viewed as interconnected parts of networks in which both production and consumption takes place (Lichter and Brown, 2011). The flow of information is becoming increasingly important within these networks (O'Hara and Stevens, 2006; Malecki, 2010), making all forms of connections and communications increasingly valuable. Economic and social developments are under pressure due to a lack of digital connectivity, impeding innovation of production processes and certain forms of consumption, and in essence excluding some rural communities from fully participating in the contemporary information society (Velaga et al., 2012; Kilpeläinen and Seppänen, 2014; Roberts and Townsend, 2015).

Following the vulnerable position of rural communities in times of upscaling of services and digitalization, LaRose et al. (2007; 2011) state that, paradoxically, the problem of physical remoteness and the inadequate service provision could for a large part be solved by promoting digital connectivity as a substitute for many of those services. Remote rural areas especially lack the required digital connectivity, however: a deadlocked situation that increases the risk of rural areas falling even further behind in terms of accessibility to services.

Researchers from various academic disciplines, including economics, IT, geography, planning, and the political sciences are engaged in researching the (potential) impact of unequal provision, adoption, and the use of ICTs. Many sub-topics are studied in-depth, resulting in a growing but somewhat fragmented body of mainly specialist literature that evades the overarching issue of the broader impact of a lack of digital developments for rural areas.

Recently, overview papers on the impact of digitalization on the economy and society have added to the debate, but they do not focus on rural areas. Some consider the consequences of digitalization for participation in the traditional 'offline' society, with a focus on urban issues (see Gilbert, 2010), while others disregard the spatial aspects of the problem (for example Cambini and Jiang, 2009; Helsper, 2012). Digital developments in rural areas are discussed in some specialist policy papers, but the focus on policy means that specific rural problems remain undiscussed (for example Holt and Galligan, 2013). This paper fills the rural gap by providing a systematic literature review on digital developments and their consequences for rural areas in advanced western countries.

3. Methodology

Although overview papers are scarce in the field of telecommunications and rural development, there are papers from related disciplines, which give an overview of the literature within their field, such as Holt and Galligan (2013) on U.S. federal universal service programs for telecommunications, and Cambini and Jiang

(2009) on broadband investment and regulation. Building on these approaches to providing an extensive overview of the literature, we will first describe how we created this overview in order to make our search queries and results reproducible. Therefore, in this section we will describe the search strategy, the selection criteria for papers, and the coding system we used for our analysis.

3.1. Conducting a systematic literature search

The systematic search is conducted with key words and concepts from academic disciplines dealing with inequalities in ICT availability and adoption, along with rural development issues. Together these key words constitute the theme of this paper. Based on the concepts and vocabulary which is used in the literature from geography, sociology, economics, and communications/telecommunications studies, as identified from a preliminary study of the main debates (see section 2), the following terms were selected for search queries to cover the ICT and digital component of our research question: "ICT," "digital," "digitalization," "telecommunications," "information technology," "broadband," "NGA," "telecommuting," "digital divide," "digital inequalities," and "information society." To cover the rural component of the research question, we used: "rural development," "rural areas," "remote area," "regional development," and "countryside." Searching with combinations of these 11 ICT and 5 rural terms generated a total of 55 search queries.

The databases 'EconLit' and 'Web of Science' were used, because they cover the cross-disciplinary scope of this paper. 'EconLit,' includes papers from over 1700 journals in economics and related disciplines, and is managed by the American Economic Association (https://www.aeaweb.org/econlit/index.php). 'Web of Science,' which is maintained by Thomson Reuters, includes over 12000 journals and combines several indexing databases from various disciplines, including IT and engineering, but also social sciences, arts, and humanities (http://thomsonreuters.com/thomson-reuters-web-of-science/).

A paper was included in the results if it was a) dealing with advanced western countries, and b) published in an English-language peer-reviewed academic journal. The queries for the Web of Science database were narrowed down after the initial results of the search were retrieved, because of its broad scope and variety of selected academic disciplines. This broader scope resulted in an abundance of mostly irrelevant – in terms of our topic – papers, such as remote sensing and crop development. The Web of Science search queries therefore were refined by only selecting the academic disciplines relevant for this paper, i.e. those dealing with digitalization issues in rural areas. Through this selection, we mainly excluded papers on developing countries and technological evaluation of remote sensing applications, for which the rural was merely a technology laboratory.

The search was executed and finished in September 2013. The 55 search queries identified 4409 potential papers. Eventually, 157 papers met the criteria of dealing with advanced western countries and being published in English-language, peer-reviewed academic journals. Recent policy documents and literature are used throughout the paper in order to position the paper's findings in the ongoing and developing debate.

3.2. Coding framework: connectivity and inclusion

For the analysis of the selected papers, we created a coding framework. This framework was created through induction. Instead of predefining the set of codes, we extracted them from our dataset (the papers), with similarities in research themes and perspectives as a basis. From the dataset of 157 papers, two main themes were identified, with four and three subthemes, respectively.

If a paper touched on more than one perspective, the code for the paper was based on which perspective and findings were emphasized in the conclusions. This is in line with the aim of this paper to extract general lessons from the debate so far. Although all the papers selected have been coded, not every paper is referred to in the text of the analysis, for readability reasons. The full bibliography, available at http://www.rug.nl/staff/k.salemink/RefList-Systematic-Literature-Review.pdf, shows the papers selected.

One main theme deals with *connectivity issues*: to what extent places and regions are digitally connected and thereby derive economic benefits. This theme has a strong supply-side perspective and corresponds to the debate on material inequalities and the digital divide (Livingstone and Helsper, 2007). This theme is further divided into four subthemes: *telecommunications markets*, *technologies in rural areas*, *regional development*, and *policy and regulation* (see Table 1 for sections, numbers of papers, and timeframe).

The other main theme consists of papers that deal with *inclusion issues*. This has a demand side and people-oriented focus, corresponding to the digital inequalities and digital inclusion debate in communication studies, geography, sociology, and urban studies (Livingstone and Helsper, 2007). These papers deal with the question of the extent to which people have the knowledge, attitudes, skills, and aspirations to be included in digital rural society. This theme is further divided into three subthemes: *diffusion theory*, *digital inequalities*, and *digital inclusion policy* (see Table 2 for sections, numbers of papers, and time frame).

4. Lessons from the connectivity literature

4.1. Connectivity

The papers described under the main theme of 'connectivity' are those dealing with material issues of the connectivity of places, regions, and in some cases households. These papers research the differences in availability of different telecommunication technologies and the mechanisms behind this. Although the search was not restricted to economic development, we found that connectivity research strongly focuses on this. Internet and ICTs facilitate the transfer of information (Malecki, 2010), and therefore they are regarded as production factors for productivity gains (Tu and Sui, 2011) and economic growth (Van Gaasbeck, 2008; Martínez and Rodríguez, 2009), either for places or individual businesses.

Research on connectivity in rural areas mainly focuses on the lack of digital connectivity in rural areas, which in the literature is referred to as the digital divide, urban-rural divide, or rural digital divide (Townsend et al., 2013). Nearly every household in advanced western societies is connected through a telephone line and, therefore, has the possibility of a fixed Internet connection. A recent communication from the European Commission (2013) and an Ofcom report (2014) show that differences in connectivity are growing, especially between urban and rural areas. The rise in deployment of Next Generation Access networks in urban areas, with greater speeds and better reliability, make these differences ever more prominent. Mobile phone coverage and mobile broadband show similar disparities (Townsend et al., 2013). In this light, we define a lack of connectivity as the comparatively disadvantaged state of connectivity of places and regions, in respect to the overall connectivity status and developments in the surrounding context, i.e. the level of connectivity of rural areas compared to urban areas.

Below we will discuss the following subthemes of connectivity separately: telecommunications markets, technologies in rural areas, regional development, and policy and regulation.

Table 1
Connectivity subthemes characteristics.

Connectivity
4.2 Telecommunications Markets
n = 13
2000–2012
4.3 Technologies in Rural Areas
n = 13
1992–2013
4.4 Regional Development
n = 25
1986–2013
4.5 Policy and Regulation
n = 32
1997–2012

Table 2
Inclusion subthemes characteristics.

Inclusion
5.2 Diffusion Theory
n = 27
2000–2013
5.3 Digital Inequalities
n = 31
2000–2013
5.4 Digital Inclusion Policy
n = 16
2000–2013

4.2. Telecommunications markets (13 papers)

The basis of a lack of digital connectivity in rural areas lies in the market for telecommunications. Privatization policies regarding telecommunication companies and deregulation of the markets in, for example, the United States (Holt and Galligan, 2013) and countries in the EU (Cambini and Jiang, 2009) have made economic market rationale the dominant assessment framework for investments in networks. In practice, there are often spatial or national monopolies, or oligopolies at best (Valletti, 2003; Atkinson, 2011). Deploying networks to rural areas, i.e. establishing connections over long distances in areas with low population density, makes these rural areas high-cost markets with little opportunity for telecommunications companies to achieve economies of scale or obtain a return on investment (Grubesic, 2010; Glass and Stefanova, 2010, 2012).

Latent demand and 'rural potential' have been mapped in the past (see for example Madden et al., 2000), but more recent literature argues that this will not affect the investment behavior of the companies (Mack and Grubesic, 2009). Even if rural areas are profitable for telecommunications companies, urban areas offer still higher returns on investment (Grubesic and Murray, 2004). This makes rural areas less attractive markets and perpetuates the urban focus of market decisions (Oyana, 2011). The market for telecommunications shows that a free-market rationale can ensure an efficient use of limited resources, i.e. using the resources for profitable markets in high-density areas, but it cannot ensure an equal delivery of services in all areas, leaving the rural underserved (Gabe and Abel, 2002; Malecki, 2003, 2004; Grubesic, 2003; Grubesic and Murray, 2004; Oyana, 2011).

The lack of provision of digital connectivity is in line with other rural service provisions, where the economies of scale of the free market lead to rural disadvantages or even a rural penalty (Hite, 1997; Malecki, 2003). However, the telecommunications market is different from other markets for rural service provision, such as the post office or a pub. On the supply side, the complexity and high costs of deploying and managing telecommunications networks form a barrier to entry into the market (Grubesic and Murray, 2004). On the demand side, consumers require connections for both household and business activities. Therefore, such connections have to be provided to a specific household or business, instead of to a single shop or hub in a village. Nowadays, digital connectivity is becoming just as important as other utilities, such as gas, water, and electricity. Up to now, the market has failed to supply this utility of the digital age (11 papers in this subtheme), and in the end it could prove necessary for governments to intervene in order to achieve universal access (see also Holt and Galligan, 2013).

EU regulations (Cambini and Jiang, 2009) and US federal policies (Holt and Galligan, 2013) focus on safeguarding a free market for telecommunications, while stimulating investment in unattractive markets. Governments have taken various approaches to ensure Internet provision for all, but to date this has not solved the problem of unequal availability and choice (Cambini and Jiang, 2009; Atkinson, 2011).

4.3. Technologies in rural areas (13 papers)

Since the development of ICTs and networks in the late 1980s, researchers have been concerned with the variety of technologies, their costs, and their availability (see for example Egan, 1992). The main concern of the literature we found involves the lack of availability and the resulting technological constraints in rural areas (see Section 4.2). Although society increasingly assumes the availability of advanced ICTs and networks, underserved rural areas are still experiencing problems in obtaining and retaining access to goods and services such as eHealth (Steele and Lo, 2013) and transport (Velaga et al., 2012) due to bandwidth constraints. When it comes to the availability of the latest technologies, rural areas universally find themselves in the same situation, that of continuously catching up with urban areas (Malecki and Boush, 2003; Grubesic, 2006, 2008).

Ellershaw et al. (2009) discuss the recent technological trend of providing wireless broadband in rural areas as a substitute for wired broadband, concluding that the need for a fiber optic backbone (wired) to deploy wireless broadband leads to only small differences in deployment costs compared to fixed broadband. As a result, here too, rural areas are at the high-cost end of the market.

With rural areas being high-cost markets as compared to urban areas, and thus remaining underserved, investments in new technologies and innovations will continue to take place in urban areas (see also Velaga et al., 2012: 105–106). Newly developed technologies are likely to be urban-led and based on ubiquitous connectivity, designed without consideration for rural needs. This dominant and largely urban rationale leads to the perpetuation of the urban-rural digital divide.

4.4. Regional development (25 papers)

As computing and digital connectivity became more and more important aspects of society in the late 1980s and early 1990s, researchers showed increasing interest in the regional economic development effects stemming from these, as shown in the 'technology' subtheme. Goddard and Gillespie (1986), Cornford and Gillespie (1993), Tsiligirides (1993), Cronin et al. (1995), and Capello and Nijkamp (1996) attempted to theoretically assess the implications of the coming digital age, envisioning a major role for advanced telecommunication technologies in future rural and regional development. Together with the influential work of Castells (2000), these early works set the tone for the debate in the field of regional development in terms of the role of advanced

telecommunication technologies. The main question in this debate in regional development is whether the availability of advanced telecommunications leads to a decrease or an increase in economic differences between places and regions (see for example Lentz and Oden, 2001; Malecki, 2003). The literature concludes that economic differences between well-connected and poorly connected regions will grow, mainly due to a lack of (instant) access to information and the limited possibility for proactively taking part in the production of information (14 papers).

Other literature concerning regional development discusses what precedes the possibility of growth: Are poorer regions capable of becoming digitally connected at all (Lera-López and Billón-Currás, 2005), and, if they are connected, do economic growth patterns develop in the same way as in advanced regions (Martínez and Rodríguez, 2009)? This issue is linked to European Union Cohesion Policy and the Digital Agenda (European Commission, 2013), and the attempts to determine whether there are similarities in problems concerning digital connectivity in the different member states. In poorer regions there is a cumulative causality: These regions suffer from a lack of connections, as a result of which regional development becomes constrained, and then regional disparities further increase (Lera-López and Billón-Currás, 2005). Over the years, these insights have contributed to an increasingly important role for ICTs and the Internet in European Cohesion Policy, connecting rural economies more strongly to urban centers and providing productivity advantages for rural businesses (European Commission, 2013). Furthermore, improved digital connectivity can help attracting human capital into these rural areas (see also Roberts and Townsend, 2015).

There is also literature concerning the measurable economic impact of digital connectivity. The general conclusion is that advanced telecommunication technologies contribute to GDP growth through investment in the infrastructure itself and through productivity improvement (Ford and Koutsky, 2005; Van Gaasbeck, 2008; Capello et al., 2011; Greenstein and McDevitt, 2011; Forman et al., 2012; Kolko, 2012; Prieger, 2013). Some papers, however, note that – although advanced telecommunication technologies do contribute to GDP growth – this growth is unevenly distributed over core and peripheral regions, that is, over urban and rural areas (Kirschner, 2005; Tu and Sui, 2011). Even if digital connectivity in rural areas improves and GDP grows, this does not automatically mean that economic cohesion is taking place. Rural areas need to grow faster than urban areas in order for economic cohesion to take place.

In the case of entrepreneurial activity, the literature is inconclusive. Although Ford and Koutsky (2005) observe that investments in broadband lead to more entrepreneurial activity in a region, Cumming and Johan, 2010, on the other hand, note that digital connectivity in remote rural areas creates Internet-based external competition for local entrepreneurs, such as e-retail, which disadvantages the local entrepreneurs. This means that improved access to markets can have a negative impact for traditional rural business. However, innovative entrepreneurs may respond positively to this competition, strengthening the rural economy in the future. Comparison can be drawn here with other modes of connectivity, such as road and rail, but this is outside the scope of our findings (see also Lichter and Brown, 2011).

Gallardo and Scammahorn (2011) show that as the number of broadband providers increases in a region, the number of non-innovative entrepreneurs, from traditional sectors, also increases. This does not mean that better digital connectivity leads to more non-innovative entrepreneurs, but it does show the importance of broadband for traditional industries. As Gallardo and Scammahorn (2011: 114) state: "… innovative entrepreneurs are less likely to start businesses in rural America (…) increasing broadband availability will enhance the development of non-innovative [traditional] entrepreneurs." For rural areas in the US, this indicates that better digital connectivity will not attract or increase the amount of creative entrepreneurs; rather, it will support existing industries. We did not find similar research in the European context, but, considering the importance of commercial counter-urbanization in the UK (Bosworth, 2010) as compared to the US, and business diversification in rural areas in the Netherlands (Markantoni et al., 2014), for example, it is debatable whether the conclusions of Gallardo and Scammahorn also apply to Europe.

The literature is also inconclusive when it comes to the role of ICT in migration to rural areas in terms of being an economic driver. Mahasuweerachai et al. (2010) conclude that digitally well-served rural areas in the United States, i.e. those with more than one broadband technology available, experience significant in-migration as compared to rural areas without broadband. Muhammad et al. (2007), on the other hand, conclude that in the Netherlands digital connectivity enables people to commute over longer distances. Through this, rural people potentially have access to labor markets which are further away.

A general conclusion is that geographical and institutional contexts do matter, so there is a potential for them to make a difference as well. For economic growth to take place, however, merely the provision of improved digital connectivity is not enough, or as Tranos (2012) summarizes it, "digital infrastructure is a necessary, but not a sufficient, condition for economic development" (Tranos, 2012: 332).

4.5. Policy and regulation (32 papers)

Digital connectivity has been a prominent topic on policy agendas for quite some time (see for example European Commission, 2013; Holt and Galligan, 2013). The main aim of policy programs has been to minimize regional disparities (see also section 4.4). The policies concerning digital connectivity have moved from the utility perspective of providing 'a connection' for all, to providing Next Generation Access for all (European Commission, 2013). The three pillars of stimulating universal and equal access to either basic broadband or NGA are competition, investment by government authorities, and regulation (Gulati and Yates, 2012). Generally speaking, policies have been forced to respond to the technological trends of advanced telecommunication technologies (Gómez-Barroso and Feijóo, 2012; Holt and Galligan, 2013). For rural development, simply reacting to these trends has not been enough, as the urban-rural digital divide shows (see Section 4.4).

Much of the policy evaluation literature discusses the imperfections or flaws in these policies (23 out of 32 papers), such as Strover (2001), and Venkatachalam and McDowell, 2003 in terms of the U.S. federal universal service programs, or Belloc et al. (2012), and Gómez-Barroso and Feijóo (2012) in terms of European Commission policy. Specifically, when it comes to the US federal universal service programs (Telecommunications Act 1996), there is a vast body of literature that discusses the effectiveness and efficacy of policy measures and programs implemented so far: Often the conclusion is that the Act and program do not deliver what they should deliver (Strover, 2003; Whitacre and Mahasuweerachai, 2008; Kandilov and Renkow, 2010; Berg et al., 2011; Holt and Galligan, 2013). Similarly inefficacious policies are found in European countries, despite the variety of efforts to promote rural connectivity - see for example Skerratt (2010) on Scotland and Nucciarelli et al. (2010) on the Netherlands and Italy.

In addition to the literature on the federal US, EU, or national levels, there is a strand of literature on municipal and county-level

policies. Local governments have attempted to get their communities connected to advanced telecommunication technologies, either through providing the capital for investments, or through the formation of a public enterprise or partnership (Sadowski et al., 2009; Nucciarelli et al., 2010; Troulos and Maglaris, 2011). North American and Australian literature on this dates back to the beginning of the 21st century (Youtie, 2000; Van Wart et al., 2000) and researches the factors that determine the success of a local government-initiated network. Conclusions suggest that supportive policy throughout the local governmental organization is required to get the locality online; unprofitable localities are very likely unable to establish an economically self-sustaining network (see also Simpson et al., 2004).

There has been specific attention for Canadian and Australian indigenous communities. Due to the remoteness of their territory, indigenous communities experience a severe lack of digital connectivity. Policy initiatives to get these remotely living communities connected to the wider world, require targeted approaches that fit into indigenous community life. Without the support of the communities, the provision of connectivity will have no impact, and will be viewed as a top-down imposition (Ramírez, 2001; 2003; 2007).

The literature on local government policy in Europe focuses on public private partnerships (PPP) for NGA networks in rural municipalities within the broader EU policy framework of the Digital Agenda and analyzes the different outcomes on the various national levels (Sadowski et al., 2009; Falch and Henten, 2010; Nucciarelli et al., 2010; Troulos and Maglaris, 2011; Ragoobar et al., 2011). Under current EU policy and law, it is difficult to set up a PPP that complies with European agreements concerning the free market (Troulos and Maglaris, 2011). The role of governmental bodies in PPPs is often challenged by commercial telecommunications companies, who claim that governmental bodies should not be acting as market parties and disrupting market mechanisms (Sadowski et al., 2009). The EU legal framework now recognizes, however, that in rural areas there often are no market initiatives, which then justifies public participation in telecommunication projects. It is moving towards a framework in which government-initiated activities in underserved 'white areas' will not immediately be forced to stop because of the prevailing interest of a free market (Sadowski et al., 2009; European Commission, 2013).

To summarize, contemporary policy and regulation is now aimed at stimulating places and regions to keep up with technological developments. There are, however, places and regions in the rural that have missed out on earlier developments. The main challenge for future policy and regulation therefore is to make sure that these lagging regions are served by the policies as well, and to prevent these regions from falling even further behind. The objectives of policy programs, e.g. providing a connection of a minimum speed and capacity, are rapidly overtaken by developments in the telecommunications sector itself (Nucciarelli et al., 2010; Ragoobar et al., 2011). The responsive character of these policies, up to now, has sustained the 'catching up' position of rural areas.

5. Lessons from the inclusion literature

5.1. Inclusion

The other main theme that arises from the papers is that of inclusion. Where papers on connectivity focus on material inequalities – in some cases from a somewhat dehumanized macro-perspective – inclusion research focuses on the social inequality aspects of ICT developments and the extent to which people are able to participate in the information society (Mariën and Prodnik, 2014). It researches the various factors and mechanisms behind the adoption of ICTs, resulting in a degree of digital inclusion for people. In addition to the availability aspect discussed in section 4, knowledge, attitudes, skills, and the aspirations to use ICTs (Helsper, 2012), along with the moment in time when people adopt these – early or late adopters – (Rogers, 2003), determine the level of inclusion into digital society.

In this section we will use the term 'diffusion theory research' for the research on the diffusion of ICTs through time and space (Section 5.2). Research on digital knowledge, attitudes, skills, and aspirations will be called 'digital inequalities research' (Section 5.3). Finally, we will discuss the literature concerning policies that promote the inclusion of digitally deprived people in rural areas into the digital society, using the term 'digital inclusion policy research' (Section 5.4).

5.2. Diffusion theory research (27 papers)

Diffusion theory research studies the socioeconomic characteristics of people with the aim of understanding how new technologies and innovations spread through time and space (Rogers, 2003). There is a vast body of literature concerning the diffusion of innovations and technologies in rural areas, and how this can be accelerated, for example, by using extension programs (Rogers, 2003: 391–394). Diffusion theorists take an educational perspective as to what the barriers are for people, firms, and organizations in terms of adopting a new technology.

The literature we found follows Rogers (2003: 281), and studies the characteristics of categories of ICT adopters, characterizing them as early adopters, late adopters, or laggards. It is interested in the extent to which (groups of) people experience barriers to adopting new ICTs, even when these ICTs are considered by policy makers as benefiting their everyday lives or businesses. Particular barriers to adoption include a lack of financial resources, unemployment, low educational levels and conservative attitudes (Hollifield and Donnermeyer, 2003; Hilbert, 2011). This literature goes beyond the urban-rural digital divide, and studies the inequality in adoption and use within rural areas. A small strand of largely descriptive literature provides overviews of 'national states of diffusion,' together with the frequently identified factors that determine adoption (Camagni and Capello, 2005; Whitacre, 2008; Zolnierek and Clausen, 2010; Khatiwada and Pigg, 2010; Turk and Trkman, 2012). Other literature takes a demand-side perspective on how to determine which factors and processes can contribute to creating more demand, and to promoting adoption of new technologies (Hollifield et al., 2000; Hollifield and Donnermeyer, 2003; Youtie et al., 2007; Turk et al., 2008; Howick and Whalley, 2008; Whitacre and Mills, 2010; Peronard and Just, 2011; Rennie et al., 2013; Hage et al., 2013). In general, people who adopt new technologies at an early stage tend to recognize the benefits of these new technologies for their everyday life, yet are also willing to accept the associated risks (LaRose et al., 2007). Moreover, early adopters in both urban and rural areas have usually had previous experience with ICTs or broadband (Hollifield and Donnermeyer, 2003; Youtie et al., 2007; LaRose et al., 2007), suggesting that there are also differences in adoption and diffusion within rural areas. Diffusion theory literature also concludes that the most important goal for future policies should be that of promoting the adoption of new ICTs by people who are not interested (see for example Howick and Whalley, 2008). Increasing the use of ICTs among this group is most likely if these are seen as a means to an end for these people (Peronard and Just, 2011) and if they fit within the culture of a community (see for example Rennie et al., 2013; on indigenous communities).

Other literature focuses on ICT adoption by firms and entrepreneurs. Forman et al. (2005a; 2005b), and Goggins and Mascaro

(2013) emphasize the role of the distance of rural firms to central market areas and of the remoteness of rural firm locations as a dominant explanation as to why rural firms lag behind non-rural firms in adopting new technologies. The diffusion theory literature this paper addresses assumes that new technologies and innovations, such as the Internet or smartphones, are first adopted in central urban areas, which hold many highly educated people with higher incomes who drive innovations (Whitacre, 2008). Eventually these innovations reach remote areas at a later stage, or not at all. Galloway and Mochrie (2005), on the other hand, conclude that distance and remoteness are not the only explanatory factors. They provide a more nuanced view of the unequal adoption of technologies, one that arises from the differences in industries and sectors, geographical context, availability of human capital within a firm, and the specificity of the technology (see also Labriandis and Kalogeressis, 2006; Jarvis et al., 2006; Galliano et al., 2001; Galliano and Roux, 2008). This means that the need for improved digital connectivity varies per sector, or even per firm. Differences like these show that there is a need for target audience programs, when it comes to improving the adoption rates in rural areas.

5.3. Digital inequalities research (31 papers)

The move towards a more nuanced understanding of the digital divide has been strongly influenced by the agenda-setting article of DiMaggio et al. (2001). They state that social sciences should study the 'social implications of the Internet' in its full complex context, instead of studying specific parts of the context. Van Dijk and Hacker (2003) later showed that, after the point of saturation for the provision of connections, there are increasing differences in skills and usage, pointing out the growing complexity of the inequalities and the digital divide. We will frame this field under the term 'digital inequalities research.' The bulk of the research that has followed is either non-spatial (see for example Helsper, 2012) or urban-focused (see for example Gilbert, 2010). Non-spatial or urban digital inequalities research assumes ubiquitous connectivity. In rural areas, however, ubiquitous connectivity (see Sections 4.2–4.4) does not exist. Conclusions based on most of the research on digital inequalities therefore do not apply to rural areas.

Although non-spatial and urban contexts are partially incommensurate with rural contexts, there is a strand of research that applies concepts from digital inequalities research to rural areas. The literature on the macro level focuses on national or other large-scale statistics, with the aim of providing an overview of the characteristics of people in relation to the use of ICTs. The determining factors that are frequently observed are age, education, gender, and income (Van Dijk and Hacker, 2003; Mills and Whitacre, 2003; Michailidis et al., 2011; Lengsfeld, 2011). This literature, however, is inconclusive as to which of the explanatory characteristics plays a dominant role in the use of ICTs.

In the micro-level literature, the research is aimed at finding out how people's lives and social positions are affected by the growing importance of ICTs, using social networks and social capital as conceptual bases (see for example Boase, 2010; Stern and Adams, 2010; Stern et al., 2011). Most micro-level literature, however, focuses on specific groups of mostly vulnerable people (see also Warren, 2007), such as rural children (Valentine and Holloway, 2001), rural youth (Laegran, 2002; Dooris et al., 2008; Awan and Gauntlett, 2012), rural women (Rubinoff, 2005), older people (Park, 2008), rural patients (Miller and West, 2009), or people living in remote areas, such as employees and teleworkers in rural areas (Simpson et al., 2003; Laegran, 2008; Brownlee et al., 2010), as well as farmers (Briggeman and Whitacre, 2010; Jeffcoat et al., 2012) and entrepreneurs (Grimes, 2000, 2003; 2005). A majority of these studies (11 of 13 papers) show that rapid digital developments make these groups more vulnerable to digital and social exclusion. An urban-led agenda that assumes ubiquitous connectivity, and adjusts policy and services to this assumption, further increases the vulnerability of vulnerable people in rural regions. In order to prevent or at least limit the impact of this, the literature concludes that the individual user should be empowered, for example by enhancing his/her skills (Briggeman and Whitacre, 2010). This empowerment, however, cannot take place without the improvement of general social and economic conditions, which ought to enable the use of digital technologies.

Generally speaking, we can conclude that low-educated, poorly literate people with little experience in using ICTs are vulnerable to exclusion from digital developments, which further increases their offline exclusion and marginalization. The attitude of people towards ICTs, and whether they aspire to use these for their existing everyday activities, along with whether they consider them useful for these practices, together determine whether people are willing to learn how to use such technologies. Merely providing the technology – the dominant rationale in connectivity research – is not sufficient to promote digital inclusion. To achieve this, inclusion research calls for user empowerment in order to make it possible for people to deal with rapid digital change. On the other hand, without material resources such as a physical connection and money for subscriptions, user empowerment is useless (Michailidis et al., 2011).

5.4. Digital inclusion policy (16 papers)

Policy studies on digital inclusion show two trends. The first attempts to create an overview of policy initiatives and their efficacy, using a macro-level and agenda-setting approach. The second uses a micro-level approach, evaluating specific (local) projects and methods designed to promote inclusion of specific vulnerable groups.

On the macro-level (6 papers), papers share the axiom that being able to use ICTs will allow people in rural areas to become more included in community life, education, and knowledge-based economic activities (Dabinett, 2000; Birch and Cumbers, 2010), through which they can eventually escape the rural penalty. These axioms are now also applied in research on transitional countries (Akca et al., 2007). However, policy programs and initiatives to promote the use of such ICTs are criticized for ignoring the rural socioeconomic and geographical contexts (Birch and Cumbers, 2010; see also Awan and Gauntlett, 2012). This results in generic initiatives with limited effects on the adoption and use of ICTs by the most vulnerable groups in rural and remote areas (Strover et al., 2004; Tookey et al., 2006). There is some literature on good practices which states that initiatives need to acknowledge the importance of community cultures and fit into community life in order to achieve the greatest possible impact (Moon et al., 2012; Lin and Wu, 2013).

On the micro level (10 papers), studies on specific projects and methods show how these projects enhance learning about ICTs, and how to use them, both for people (Uotinen, 2003; Suhonen and Sutinen, 2006; LaRose et al., 2011) and for firms in remote rural areas (Sellitto and Burgess, 2005). The general view in this literature is that, in the case of arrears, the government should take the lead in organizing inclusion-promoting projects. To achieve the greatest possible effect, Gripenberg et al. (2004) state that the government should consider handing over the management of the project to the people of the community, for whom or with whom the project has been designed. This way, the community itself is responsible for making the project activities fit into the community's culture.

Within this subtheme there is a specific focus on indigenous

people, just as in the connectivity policy subtheme (see Section 4.5). The Australian literature concludes that, although indigenous communities currently are the digitally most deprived group (Bandias and Ram Vemuri, 2005), there is potential for an increase in usage in these communities. To achieve this, Morrison (2000) claims that community governance bodies should be given the authority to determine policy and activities. They are regarded as knowing best what or who can be a driver for people to adopt and promote the usage of ICTs. Lindberg and Udén (2010), on the other hand, observe the key role women play as drivers towards innovative ICT application, in their case in a reindeer-herding Sámi village. They also stress that the role of gender in ICT adoption is culturally and community specific.

The inclusion policy literature, especially the micro and project level papers, shows the determining influence that the geographical, social, economic, and cultural context has on the efficiency and efficacy of policy initiatives. Activities to promote learning about ICTs and their usage need to fit into the everyday activities of a community and suit its culture. Problems in different regions and communities do show similarities, but generic policy approaches have proven to be ineffective. Moreover, many regions and communities have yet to bridge the gaps they experience. There is more chance of achieving this by including these communities in the decision-making and implementation, or by introducing community ownership of projects. In Europe there is now an opportunity to bring this idea into practice, with the new EU Cohesion Policy (2014–2020) focusing more on community-led local development (European Commission, 2014).

6. General conclusions and prospects for digital rural development

6.1. Market dependency and the urban-rural divide

This systematic literature review provides an overview of the shifting focal points and topical issues in the debate on digital developments and rural development. The debate is somewhat fragmented over various disciplines and themes, yet we have extracted prevailing ideas on how rural development is affected. Together, the 157 selected papers recognize, either implicitly or explicitly, that society as a whole is moving towards a digital information society, in which access to and use of data infrastructure are essential. Authors dealing with rural issues follow the work of key scholars in this debate (Castells, 2000; DiMaggio et al., 2001; Helsper, 2012). The prevailing idea is that, in order to have equal opportunities for every person, household, and firm, everyone should be connected to high speed Internet. Furthermore, people have to know how to effectively use ICTs for their economic benefit or their quality of life, i.e. to keep up with developments. Not keeping up is considered as leading to “digital exclusion,” “lagging rural development,” or “economic decline” (see Table 3).

Theoretical considerations as to how the digital society should develop in order to create benefits for everyone are in great contrast with rural reality. Developments so far indicate that telecommunication companies will not provide every rural household or business with a high-speed Internet connection comparable to those in urban areas. Rural areas are served last, if they are served at all (see for example the case of cable Internet; Nucciarelli et al., 2010: 514). The speed and reliability of connections in rural areas demonstrate this. Compared to urban areas, the profit opportunity in rural areas is lower because of the high costs of covering greater distances. Companies are only willing to deploy a network if households and businesses pay a higher price to make up for these higher deployments costs. Insights from the connectivity debate (section 4) show that, under the current conditions, we can expect that the urban-rural divide will persist or even grow, as new, faster technologies come on-stream, perpetuating the rural penalty.

This literature review also serves as a warning to policy makers. Since the early 1990s, several academics have pointed out the potential of high-speed telecommunication networks for regional and rural development (see sections 4.5 and 5.4). This theoretical potential now has turned into a claim based on empirical grounds: Digital connectivity either stimulates productivity and growth, or it limits further decline. With this message there has always been a warning from academia to governments and policy makers that the high costs of deploying the infrastructure would deter telecommunication companies from investing in rural networks. Considering the current state of digital connectivity in rural areas, this warning has come true.

This paper has shown that there is a growing consensus that poor rural telecommunication infrastructure hinders rural development. However, policies for promoting the availability of connections, along with the adoption and use of ICTs, have been responsive in character, and largely unsuccessful. Generic policies appear to be inappropriate, or, as Belloc et al. state: “… different policy combinations suit different policy objectives (…) different initial conditions: there is no one-size-fits-all policy” (2012: 397). To ‘customize’ policies, however, making use of local knowledge of the various rural stakeholders seems fundamental.

A general conclusion from the literature on connectivity is that governments have only been able to react to market and societal developments, instead of anticipating them. By promoting the free-market rationale and using competition as the instrument for improving digital connectivity, instead of defining new technologies as utilities, governments have limited their influence on digital development, allowing for market failure (Atkinson, 2011). This has brought about programs to stimulate digital connectivity in rural areas with technologies and minimum service levels that were already outdated by the time they were deployed (see section 4.5). The EU's struggle to deal with NGA technologies, while still promoting basic broadband, is a striking example of this (see also Nucciarelli et al., 2010; Ragoobar et al., 2011). It shows the need for place-specific and community-specific policies, since needs and demand are defined locally.

In times of ever growing global competition, the digital rural penalty might result in a further loss of competitiveness of rural regions, affecting the overall competitiveness of national economies. The paradox in this digitalizing age is that the regions most in need of improved digital connectivity, i.e. rural regions in decline, are the regions which are the least connected and included. Next Generation Access may not necessarily be a public service, but considering how much public value it can create, it can be seen as a public good that is required in order to provide other (public) services, such as eHealth and eGovernment (see sections 4.5 and 5.4).

6.2. Towards a community-based research agenda

A general question that has come up in the analysis of the papers is the extent to which the debate on digital inequalities is an entirely new one. And, more fundamentally, is there a tangible digital society from which people and places can be excluded? The two main research directions that we discerned in this paper, connectivity and inclusion, are not new. The ability to connect to and be included in major developments, as a prerequisite for growth, is omnipresent in regional development and social inclusion literature (see sections 4 and 5). The digital context, however, is relatively new. There is, nevertheless, much to be learned from existing offline arrears and the lagging diffusion of technologies. Future research should bring together theories from previous research on ’analog’ connectivity, accessibility and inequality

Table 3
Summarized overview of digital connectivity in rural development.

Connectivity	Effects on rural development
Telecommunications Markets	Rural areas do not provide enough market potential for investments; profit potential is larger in urban areas
n = 13	Lack of investment in telecommunication technologies
	High investments in urban areas, low investments in rural areas: urban-rural digital divide
Technology	Lack of availability and choice of technologies
n = 13	Limited opportunity for activities that require telecommunication technologies
	Wireless technologies are also limited by market deficiencies; it is not yet an alternative in rural areas
Regional Development	Mixed conclusions on GDP growth, entrepreneurial activity, migration to rural areas
n = 25	Due to continuous developments in urban areas, rural areas are not catching up, so no cohesion is taking place
	Traditional industries benefit especially from increased digital connectivity; it is less likely that rural regions will attract innovative or creative industries
	Axiom that regions benefit from improved digital connectivity
	Improved digital connectivity opens up the rural for competition from outside
Policy and Regulation	Policies have a responsive character
n = 32	Technological development moves faster than policy development
	Sector-scattered interest
	Free-market rationale has hindered developments in rural areas, especially in Europe; governments have not been allowed to interfere
Inclusion	
Diffusion Theory	Diffusion of ICTs through space and time, with a demand-side focus
n = 27	Traditional view: Remoteness of rural areas places rural communities at the end of the diffusion stage; late adopters and laggards
	Adoption and use of ICTs in rural areas is also constrained by lagging supply
	Willingness to adopt new ICTs in firms differs per sector
Digital inequalities	Knowledge, skills, attitudes, and aspiration are key factors in why and to what extent people use ICTs
n = 31	Digital empowerment depends on wider offline-based socioeconomic contexts
	Low educational levels and skill levels in rural areas are considered a problem
Digital inclusion policy	Generic policies are incapable of reducing inequalities
n = 16	Impact of policies and projects depends on the extent to which local community culture and practices are taken into account
	Policies are more likely to succeed if communities are involved in the decision-making; community ownership of projects is preferable

issues, and research on 'digital' forms of these issues. For a comprehensive understanding of digital rural development, the largely offline-based economic history and everyday life ought to be part of the research agenda. Digital developments are not something 'virtual' which takes place online; these developments are based in real life.

This paper has demonstrated that, up to now, research on digital development in the rural consisted of two major strands of research – connectivity and inclusion – each with its own focus. Research on connectivity issues (section 4) is largely place-based and focuses on supply side arguments, such as deployment costs, and economic impact. Dominated by economic thinking, the urban focus of markets is regarded as a contextual fact when discussing the position of the rural. In this context, top-down regulatory measures and subsidies are the most common instruments to deal with the urban-rural divide (section 4.5). Research on inclusion issues (section 5) is largely people-based and focuses on demand side and bottom-up elements, such as diffusion, skills, affordability, cultural differences and attitudes towards ICTs. The focus on the inclusion of all people, regardless of their background, can help showing the public value of ICTs and improved digital connectivity (sections 5.3 and 5.4). Moreover, inclusion research can provide the market with insights on latent demand of excluded and disconnected groups in the rural; insights which can be used to potentially bridge the gap between demand and supply.

The potential role of inclusion research in stimulating, and eventually bundling, (latent) demand in the rural is the reason why we call for a more integrated research agenda for digital rural development, in which connectivity and inclusion are no longer separate strands of research. Inclusion research should focus on

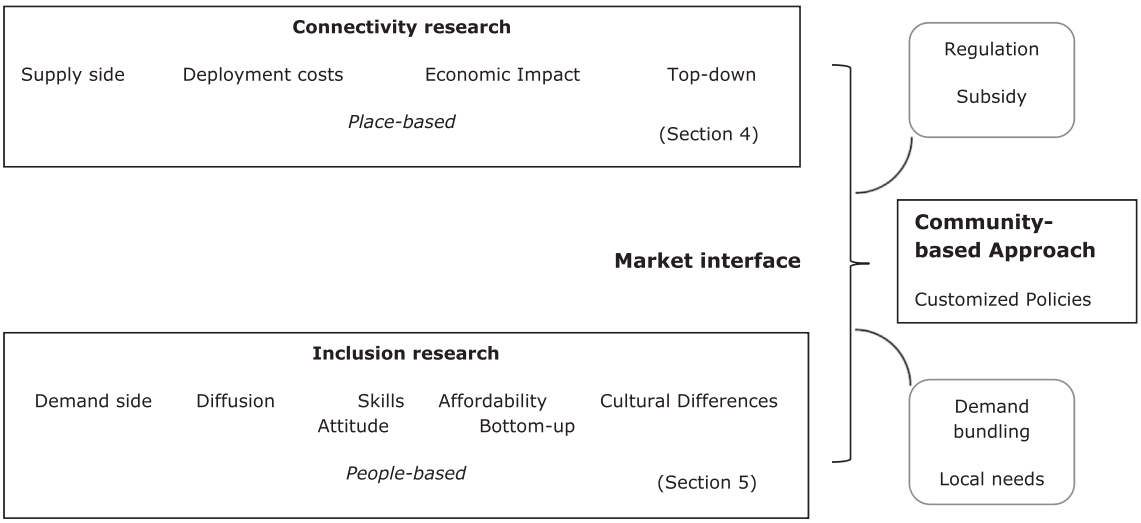

Fig. 1. Combining connectivity and inclusion research to create a community-based approach.

community processes which can stimulate and bundle local demand, which is often still fragmented over various stakeholders and consumers. Connectivity research, on the other hand, should focus on how markets can serve these increased demand levels in rural areas. Both focal points are in need of a reflection on the role of national and local governments. The question then is: To what extent are rural communities, united in civic initiatives or community action groups, and telecommunications companies able to regulate this process together, and where do they need government support? The purpose of the design is that connectivity and inclusion research are combined and applied in specific community contexts. Our idea for this agenda is presented in Fig. 1.

Generic policies have not solved the urban-rural digital divide. The rural is in need of 'customized' policies, but telecommunications companies cannot serve every individual need. The community level seems an appropriate intermediate level for negotiation between the generic (national) level and the individual level. We argue that connectivity research and inclusion research can be brought together in a community-based approach, which facilitates market interface at the community level. Various local needs can be brought together (see Fig. 1).

The community level allows for local cultural differences to be recognized in demand bundling processes. Once the local demand is bundled, this can trigger the market to serve the rural community on the community's terms. If the market is not triggered, the demand bundling process can at least make clear what the gap is between demand and supply. In this way, the community-based approach results in a rural business case, which is either market-ready or in need of a specific level of government support. Based on insights from the debate so far, we can expect that socially excluded communities, and communities which lack financial and social capital, will be most in need of government support in this community-based approach. Digital connectivity and digital inclusion are becoming increasingly important in the digital age, but 'offline' social and economic developments will continue to resonate in the field of rural development.

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