RESEARCH PAPER

Three decades of research on innovation and inequality: Causal scenarios, explanatory factors and suggestions

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ABSTRACT

Prompted by rising income inequality (in short, inequality) in advanced economies, a rapidly growing number of studies across various fields and disciplines of social science have, since the 1990s, sought to find out how innovation (as the main engine of economic progress) affects the distribution of income in modern-day capitalist societies. Using the systematic literature review method, this paper provides the first critical review of 166 studies on innovation and inequality published in 114 journals in the last three decades (1990–2019). It is shown that, while the great majority of studies under review concur that innovation induces inequality, this finding is subject to the disciplinary origins of research (e.g., development studies, economics, geography, innovation studies, etc.) and the country under investigation. Furthermore, guided by an original causally holistic analytical framework, the analysis demonstrates that the relationship between innovation and inequality is significantly more causally complex than the most popular theoretical perspective (i.e., skill-biased technological change account) has let us believe; in particular, it is subject to five causal scenarios and a range of explanatory factors (i.e., skill premiums, technological unemployment, international trade, declining union membership, spatial aspects, changing employment conditions, policy, horizontal inequalities, sectoral composition and types of innovation). The paper ends by discussing findings, policy implications and knowledge gaps, one of which concerns the following under-researched question: how, and under what conditions do publicly funded innovation policies reduce (or increase) inequality?

Introduction

What do the contributions of notable thinkers – such as Adam Smith (1776/1982), David Ricardo (1891), Karl Marx (1999), Thorstein Veblen (1899/2009), Joseph Schumpeter (1934, 1944) and Werner Sombart (1967) – have in common other than their obvious significance for contemporary socioeconomic thought? In a nutshell, the classics of socioeconomic thought are replete with passages demonstrating that innovation[1] is (bi-)causally related to inequality[2] in capitalist societies. Despite this, innovation scholars had, for several decades of the twentieth century, examined mainly the positive side of the story, particularly the relationship between innovation, employment creation, competitiveness and growth (Fagerberg, 1994; Pianta, 2005; Antonelli, 2009). The question of

[1]In this paper, innovation is defined as the development of novel and socioeconomically significant combinations of resources, which can take the form of new products, services, institutions and organizational models (Edquist, 2005; Fragkandreas, 2017).

[2]Broadly defined as the unequal distribution of income (Tilly, 1998; Dorling, 2019).

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inequality was largely ignored. Today, however, there exists a sustained interest in innovation and inequality in various fields of social science. For instance, economists (e.g., Acemoglu, 2002; Van Reenen, 2011), economic geographers (e.g., Breau *et al.*, 2014; Lee, 2016), development scholars (e.g., Hilbert, 2010), industrial relations scholars (e.g., Belman and Monaco, 2001), innovation scholars (e.g., Cozzens and Kaplinsky, 2009; Lazonick and Mazzucato, 2013), sociologists (e.g., Fernandez, 2001) and political scientists (e.g., Hope and Martelli, 2019) have all examined the relationship between (technological) innovation and inequality.

Despite such a discipline-diverse interest, our knowledge of this rapidly expanding literature has, to date, been overshadowed by the work of mainstream labour economists (Ashenfelter and Card, 2010), particularly by research informed by the skill-biased technological change (SBTC) account.[3] Thanks to a few literature reviews on SBTC research (e.g., Acemoglu, 2002; Acemoglu and Autor, 2011; Bogliacino, 2014; Goos, 2018), we know a great deal about the work of mainstream economists on innovation and inequality, but much too little about the work, for instance, of development studies scholars, heterodox economists, employment relations scholars, innovation scholars, geographers and sociologists.

This 'disciplinary parochialist' (Sayer, 2000a) perspective has several important ramifications for research and policy. First, it limits the cross-fertilization of knowledge, including the formation of interdisciplinary research synergies and projects, among like-minded scholars in the social sciences. Secondly, and as will be shown in this paper, it propagates assumptions about innovation and inequality that have long been found to be fundamentally misleading and fallacious in another field of study. Finally, a disciplinary perspective reduces the knowledge variety – a necessary element in designing a new generation of inequality-sensitive and inclusive innovation policies (Perez, 2013; Zehavi and Breznitz, 2017; Schot and Steinmueller, 2018; Edquist, 2019).

The present paper redresses the lack of an interdisciplinary assessment of the current stock of knowledge on innovation and inequality. It does so by identifying and reviewing, in a critical manner, 166 studies published in a broad range of journals (114) in the last three decades (1990-2019). A major novelty of the present review is that, unlike previous reviews on the subject, which are narrative and focus exclusively on research within only a single field (e.g., Acemoglu, 2002; Acemoglu and Autor, 2011; Van Reenen, 2011; Bogliacino, 2014; Lee, 2016; Goos, 2018), the analysis in this paper is cross-disciplinary (i.e., synthesizing knowledge from different fields), systematic (i.e., based on the systematic literature review method) and causally holistic (i.e., utilizing an original conceptual framework). All of this enables the review process to cross freely the disciplinary boundaries of knowledge and identify several overlooked aspects of causality in the relationship between innovation and inequality.

Several novel insights and critical observations emanate from the analysis. First, it is shown that while, in quantitative terms, the extant research concurs that innovation induces inequality, one needs to be extremely cautious about the validity of this finding. This is because the disciplinary origins of research (e.g., economics, development studies, sociology, etc.) and the country under investigation seem to affect the propensity of research to report that innovation induces inequality. Secondly, against the STBC account, which rests upon a one-dimensional perspective on causality, this review shows that there are five main causal possibilities through which innovation and inequality are causally related. These are as follows: absence of causality (causal scenario 0); innovation induces inequality (causal scenario I); inequality stimulates innovation (causal scenario II); innovation

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[3]According to this account, innovation has – for much of the twentieth century – been complementary to skills in general, and the labour productivity (and thus also wages) of the skilled labour force in particular (Card and DiNardo, 2002; Acemoglu, 2002; Van Reenen, 2011). Innovation, as SBTC scholars argue, induces inequality by increasing the wage gap between skilled and unskilled employees (Acemoglu, 2002; Van Reenen, 2011; Bogliacino, 2014; Goos, 2018). At the macro-level, the SBTC account predicts that the more technologically advanced the modern capitalist system becomes, the more polarizing the distribution of skills and wages among workers tends to be (Autor *et al.*, 1998; Krusell *et al.*, 2000).

ameliorates inequality (causal scenario III); inequality hampers innovation (causal scenario IV). Thirdly, the analysis identifies numerous determinants (i.e., skill premiums, technological unemployment, international trade, declining union membership, geographical aspects, changing employment conditions, policy, horizontal inequalities, sectoral composition and types of innovation) that appear to be shaping (in the form of causal mechanisms) the multidimensional direction and strength of causality. Finally, and because of its critical outlook, the paper detects and challenges several prevalent assumptions and methodological practices, such as the following:

1. The lack of a sophisticated understanding of innovation as a highly uncertain, collective (multi-actor), organization-specific and sectorally differentiated activity;
2. The widely held theoretical assumption that income acquisition is being primarily shaped by atomistic (human capital) attributes in labour markets, rather than being the primary outcome of relationally created and maintained processes that occur mainly in concrete, unequally structured organizations, such as the innovative firm;
3. The widely adopted methodological practice in which the identification of a few statistically significant associations, including the absence of them, is treated as conclusive evidence of operative causal mechanisms; and
4. The easy extrapolation of the research findings in the liberal market economies (e.g., the US, the UK and Canada) to the other market economies (e.g., coordinated and mixed market economies).

The analysis in this paper responds, albeit in a different manner than customary (e.g., concrete research), to recent calls made by innovation scholars (e.g., Soete, 2013; Martin, 2016; Chaminade *et al.*, 2018; Schot and Steinmueller, 2018; Coad *et al.*, 2021) that inequality needs to be placed much higher on the research agenda in the field of innovation studies.[4] By offering an up-to-date, causally holistic analysis of the extant multidisciplinary lines of research, the paper transforms a highly fragmented body of research into a coherent guide to the current empirical stock of knowledge on innovation and inequality while also suggesting several cross-disciplinary (yet consistent with the theoretical core of the field of innovation studies) paths of research on a topic of increasing scientific and policy relevance (Fagerberg *et al.*, 2012; Martin, 2012; Lundvall, 2013).

The remainder of this paper consists of four sections. The second introduces key stylized facts of inequality research, before spelling out the key dimensions of the analytical framework of this review. The third discusses the key steps and procedures that this paper has followed to identify and analyse, in a systematic manner, the extant research on innovation and inequality, whereas the fourth provides a chronological review of the literature, focusing on bibliometric issues (e.g., prolific authors, journals, disciplines and keyword developments), causal scenarios and explanatory themes. The paper ends with a summary of key findings, knowledge gaps, policy implications and suggestions.

Innovation and inequality: theoretical background and review framework

Rising inequality: key trends and determinants

Over the past three decades, numerous studies have shown that inequality has been galloping in both developed and developing economies (e.g., Stiglitz, 2012; Piketty, 2014; OECD, 2015; Lakner

[4]By innovation studies, this paper refers to the half-century-old, cross-disciplinary field of research whose primary aim is to study, in a systematic manner, the nature, determinants, social and economic benefits and consequences of innovation (Fagerberg *et al.*, 2012; Lundvall, 2013). While diverse, much innovation studies research falls into three main strands (Fagerberg *et al.*, 2012; Lundvall, 2013): the economics of innovation strand (Fagerberg, 2003); the management and organization of innovation strand (Tidd and Bessant, 2018); and the socioeconomic strand dealing mainly with the diffusion of innovation (Rogers, 1995), innovation (eco)systems (Edquist, 2005; Granstrand and Holgersson, 2020) and sociotechnical systems and transitions (Geels, 2004).

and Milanovic, 2016; Milanovic, 2016). OECD data confirm that, as measured by the Gini coefficient,[5] inequality has risen considerably in nearly all of the 37 OECD member states: from 0.29 in the mid-1980s to 0.315 in 2013 (OECD, 2015). Similarly, the 90/10 percentile (another widely used measure of inequality) shows that the wealthiest 10% of the population in OECD countries earned ten times more than the remaining 90% of the population in 2013 (OECD, 2015). Compared with the 1980s, this ratio has increased by 37%. Other studies show that the top 1% of income earners (i.e., 99/1 percentile) have made unprecedented income gains (Atkinson *et al.*, 2011; Alvaredo *et al.*, 2013; Dorling, 2019), and this has occurred at a time when some quite old and worrisome social phenomena – such as the 'working rich', 'working poor', 'underpaid and overworked' – have been re-emerging from the dustbin of economic history (Bogliacino, 2009; Lohmann, 2009; Sayer, 2015; Pianta, 2018; Dorling, 2019).

One may wonder why has inequality kept rising during one of the affluent periods in the history of the capitalist system? After all, eminent economists, such as Milton Friedman (2002), as well as the public speeches of iconic conservative politicians (e.g., Margaret Thatcher and Ronald Reagan), have taught us that growing inequality is a transitory social evil on the path to economic equality in capitalist societies (Harvey, 2005; Senker, 2015; Albertson and Stepney, 2020). Similarly, Kuznets's (1955) inverted-U curve hypothesis (also known as the Kuznets curve) predicts that inequality rises in the early stages of economic growth, then it peaks, before subsequently reaching a historic low (cf. Alderson and Nielsen, 2002; Stiglitz, 2012; Piketty, 2014; Milanovic, 2016).

Traditionally, social scientists – especially Marxist economists, geographers and sociologists – have approached the question of rising inequality from the standpoint of the class struggle (e.g., Braverman, 1974; Peet, 1975; Wright, 1994; Smith, 2010; Piketty, 2014; Papaioannou, 2016). From this perspective, inequality is the outcome of (over)exploitation between the two antagonistic social classes in capitalist societies, namely capitalists and labourers. Dissatisfied with the abstract and deterministic outlook of the class struggle perspective, more recent research (circa 1990s) has sought to understand rising inequality in a more theoretically and empirically diverse manner (Neckerman and Torche, 2007; Lemieux, 2008; Vallas and Cummins, 2014; Cavanaugh and Breau, 2018).

Today, inequality researchers tend to agree that income inequality is a multidimensional and multi-determined phenomenon in the sense that it contains various interrelated forms (e.g., wealth, education, health inequality etc.) (Bourdieu, 1987; Tilly, 1998; Fragkandreas, 2012; Dorling, 2019), as well as being shaped by various (multi-scalar) factors and forces, such as education, gender, race, international trade, immigration, declining union membership and minimum wages, financialization, unequal organizational structures, neoliberal policies, and welfare state retrenchment (Neckerman and Torche, 2007; DiPrete, 2007; Lemieux, 2008; Donegan and Lowe, 2008; Piketty, 2014; Tomaskovic-Devey, 2014; Stockhammer, 2017; Cavanaugh and Breau, 2018; Munir, 2021). From these factors, however, it is innovation which, according to a growing number of contributions, constitutes one of the most significant causal determinants of rising inequality in contemporary societies (e.g., Fernandez, 2001; Acemoglu, 2002; Angelini *et al.*, 2009; Cozzens and Kaplinsky, 2009; Van Reenen, 2011; Lazonick and Mazzucato, 2013; Lee, 2016; Pianta, 2018).

Innovation and inequality: review framework

How does innovation shape the distribution of income in contemporary societies? Unfortunately, owing to the predominance of skill-biased technological change (SBTC) research,[6] the broader academic discourse regarding innovation and inequality gives the impression that all that exists, in

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[5]For an overview of the measures of inequality, see Allison (1978) and McGregor *et al.* (2019).

[6]For instance, in one of its reports on inequality, the OECD (2011) describes the SBTC hypothesis as the leading explanation of rising inequality in the OECD economies. Similarly, critics of the account in question point out that '[m]any inequality scholars view skill-biased technological change … as the main cause of rising wage inequality' *(*Kristal and Cohen, 2017, p.218).

terms of causality, in the relationship between innovation and inequality is that the former has a significant impact on the latter, mainly through the skill premiums mechanism.

However, a closer examination of the relevant (empirical) literature reveals an entirely different picture. On the one hand, and in line with the SBTC account, several studies suggest that innovation is positively associated with inequality (e.g., Krueger, 1993; Lee, 2011; Breau *et al.,* 2014). On the other hand, and in contrast to the SBTC account, other contributions allude to the fact that innovation lessens inequality (Lundvall, 2002; Heeks *et al.*, 2014; Antonelli and Gehringer, 2017). Yet another line of research demonstrates that it is inequality that affects, either positively or negatively, the development of innovative activities in contemporary societies (e.g., Falkinger and Zweimüller, 1997; Tselios, 2011; Vona and Patriarca, 2011; Woodson *et al.*, 2019). Thus, to offer an eclectic disciplinary overview of the existing empirical literature, as well as to analyse, reconcile and synthesize contradictory research findings, this paper develops an analytical framework (henceforth, review framework). Central to this are five causal scenarios, each of which has its own theoretical origin.

- *Causal scenario 0 – absence of causality.* Today, it is commonplace to argue that innovation is a major force behind rising rates of labour productivity, employment creation, profitability, growth and standards of living in general (Schumpeter, 1934; Freeman and Louca, 2001; Pianta, 2005; Antonelli, 2009). However, this was not always the case. Neoclassical economists (e.g., Solow, 1956), for instance, had long argued that economic growth is best studied as a function of two factors: capital and labour. This view, among others, was challenged by early neoclassical growth research, particularly by Solow (1957), whose analysis of US growth shows that the variables of capital and labour leave unexplained as much as 90% of the variance in US growth rates. To account for this residual (also known as the 'Solow residual'), innovation was introduced – initially in the form of technical change (a total factor productivity measure) – to a new generation of neoclassical growth models (Fagerberg, 1994; Antonelli, 2009). As far as the relationship between innovation and growth is concerned, neoclassical growth theory implies that rising technological intensity and inequality are two unrelated phenomena (Violante, 2008; Cozzens and Kaplinsky, 2009): innovation is assumed to be exogenous and factor-neutral, meaning that it benefits the skills, marginal productivity and average wages of all economic agents equally. Although no longer influential, the neoclassical perspective on growth raises, in the context of this study, the possibility that innovation and inequality may not always be (bi-)causally related.
- *Causal scenario I: innovation induces inequality.* According to Schumpeter's (1934) theory of economic development, innovation encompasses the development of new products, services, organizational models and markets. In doing so, innovation creates new competences, while gradually destroying those that are no longer needed in the innovation process (Archibugi and Lundvall, 2001; Lundvall, 2002). When the competence-building process is socially exclusive (rather than inclusive), innovation tends to intensify existing socioeconomic inequalities, such as horizontal (gender and racial) inequalities (Gray *et al.*, 1998; Asheim and Gertler, 2005; Cozzens and Kaplinsky, 2009; Juhn *et al*., 2014; Cheng *et al.*, 2019; Feldman *et al.*, 2021). In a similar manner, the skill-biased technological change (SBTC) account maintains that innovation creates and intensifies skill premiums, i.e., the wage gap among skilled and less skilled employees (Acemoglu, 2002; Violante, 2008), while the more recent version of the SBTC account (i.e., task or routine-biased technological change account) argues that innovation leads to income polarization through both skill premiums and technological unemployment; for instance, by replacing highly routinized job tasks with artificial intelligence and robots (Autor *et al.*, 2003, 2008; Brynjolfsson and McAfee, 2012; Frey and Osborne, 2017; Goos, 2018; Pianta, 2018, 2020; Cirillo *et al.*, 2021). Furthermore, owing to its highly uncertain and failure-prone character (Schumpeter, 1934, Kline and Rosenberg, 1986), innovation can embed an unequal distribution of risks

and rewards (Lazonick and Mazzucato, 2013). Thus, when the costs of innovation are collectively undertaken (e.g., state, universities, research institutes), but the benefits of innovation are distributed mainly within the boundaries of the innovative firm (e.g. shareholders, top executives and employees), innovation can lead to (top) income inequality (Lazonick and Mazzucato, 2013; Bapuji, 2015; Aghion *et al.*, 2019; Tomaskovic-Devey and Avent-Holt, 2019; Munir, 2021).

- *Causal scenario II – inequality stimulates innovation*. The idea that inequality shapes the nature and direction of innovative activity has a very long intellectual pedigree in social science. For instance, Karl Marx's (1999) work on social class, Thorstein Veblen's (1899/2009) analysis of the leisure class, Werner Sombart's (1967) theory of economic development, and, more recently, Pierre Bourdieu's (1987) work on social distinction, underline that inequality has a profound effect on innovation (and economic development in general). In a similar manner, neoclassical economists have long believed that inequality provides strong incentives for economic agents (i.e., incentive thesis) to do the 'right things', such as working harder (e.g., productivity gains) and engaging in growth-boosting (Schumpeterian) activities, such as innovation and entrepreneurship (Falkinger and Zweimüller, 1997; Samuelson, 2010; Sayer, 2015; Xavier-Oliveira *et al.*, 2015; Stiglitz, 2012). Therefore, in theory, it is not only that innovation shapes the distribution of income, but also that the latter moulds the former.
- *Causal scenario III – innovation ameliorates inequality*. Traditionally, innovation has been associated with increased standards of living and economic equality (Schumpeter, 1934; Kuznets, 1955; Freeman, 2001; Freeman and Louca, 2001). For instance, in the golden (Fordist) age of capitalism (between the 1940s and the 1970s), innovation-driven growth led to a significant reduction in (male) unemployment and inequality rates (Freeman, 2001; Pianta, 2005; Cozzens and Kaplinsky, 2009; Atkinson *et al.*, 2011). Because of its creative nature, innovation requires the creation of new competences (Archibugi and Lundvall, 2001; Lundvall, 2002). When the competence building process involves marginalized social groups and actors, innovation can mitigate existing horizontal inequalities (Freeman, 2001; Lundvall, 2002; Arndt *et al.*, 2009; Cozzens and Kaplinsky, 2009; Heeks *et al.*, 2014). In addition, by being a creative destructive process (Schumpeter, 1944), innovation undermines the nature of wealth inequality while also fostering social mobility, as when innovators and entrepreneurs belong to marginalized social groups (Heeks *et al.*, 2014; Antonelli and Gehringer, 2017; Kim and De Moor, 2017). Thus, as with the previous causal scenarios, innovation can mitigate inequality through various causal mechanisms and processes.
- *Causal scenario IV – inequality hinders innovation.* In line with Adam Smith's (1776/1982) theory of the division of labour, Schumpeter's (1934) theory of economic development assumes that the entrepreneurial act of innovation reduces inequality and poverty in capitalist societies over time (Freeman, 1994, 2001; Antonelli and Gehringer, 2017). However, in his subsequent work, and echoing the work of Marx (1999) and Veblen (1899/2009), Schumpeter (1944) argues that innovation reinforces existing socioeconomic inequalities in capitalist societies. Schumpeter goes as far as to claim that, if unabated, rising inequality erodes the institutional foundations of long-term economic growth in capitalist societies, potentially leading to the displacement of capitalism by socialism (Elliott, 1980; Henrekson and Jakobsson, 2001; Fagerberg, 2003). Rising inequality engenders crime and corruption, both of which can, over time, transform inclusive institutions into extractive ones (Neckerman and Torche, 2007; Acemoglu and Robinson, 2012; Stiglitz, 2012). The latter can reinforce the significance of certain forms of social capital (e.g., bonding social capital), thus prohibiting the formation of alternative forms of social capital (e.g., bridging social capital) among socially and cognitively diverse actors in the innovation process (Archibugi and Lundvall, 2001; Nielsen, 2003; Fragkandreas, 2012; Barnes and Mattsson, 2016). Furthermore, by reducing the overall demand for new products and services (Falkinger and Zweimüller,

1997; Jung *et al.*, 2018) while also increasing social costs (e.g., tensions and frictions) among affluent and less affluent social groups (Cozzens and Kaplinsky, 2009; Juma, 2016), inequality can hinder the adoption of socially desirable radical innovations (e.g., COVID-19 vaccines), sustainable technological transitions and structural change in general (Freeman, 2001; Geels, 2004; Cozzens and Kaplinsky, 2009; Riaz, 2015).

Figure 1 provides a graphical representation of the review framework.[7] The remainder of this paper utilizes this framework as a guide to analysing and synthesizing the findings of the existing research on innovation and inequality.

Review method, sample and analysis

Systematic literature review

As mentioned in the introductory section, there exists a large body of research on innovation and inequality in various fields of social science. This, in turn, begs the following methodological question: how can one identify, select and critically review the most relevant studies on innovation and inequality? To address this question, this paper adopts the systematic literature review (SLR) method (Tranfield *et al.*, 2003; Petticrew and Roberts, 2008).

Originally used in medical studies, the SLR method is increasingly being adopted in the social sciences (Tranfield *et al.*, 2003; Petticrew and Roberts, 2008; Haddaway *et al.*, 2015). As far

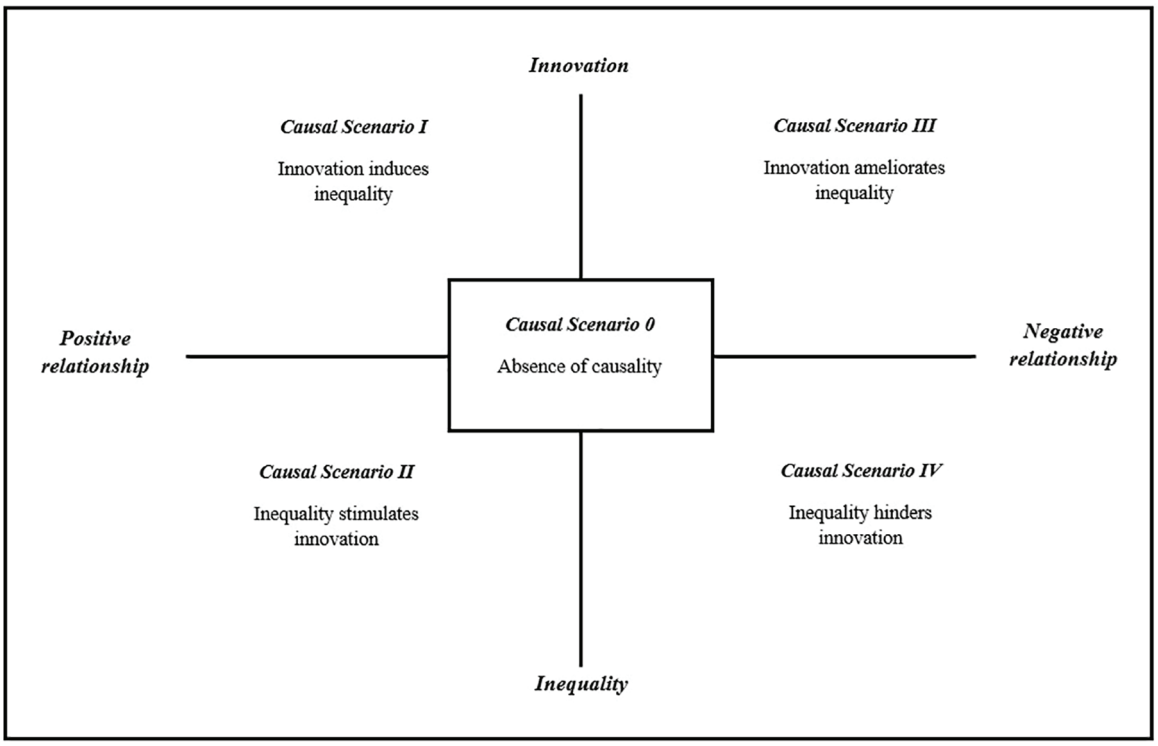

Figure 1. Innovation and inequality – review framework

Source: own elaboration

[7]It is important to note that Figure 1 offers a schematic overview of the five main causal scenarios in the relationship between innovation and inequality. Because it is simplified, the figure purposely leaves out the indirect links, causal mechanisms and conditional factors in each causal scenario. I would like to thank Hans-Jurgen Engelbrecht for encouraging me to bring this issue to the reader's attention.

as innovation research is concerned, SLRs have recently emerged as the methodological norm when it comes to reviewing the current stock of knowledge on innovation (e.g., Martin, 2012; Doloreux and Porto Gomez, 2017; Compagnucci and Spigarelli, 2020; Kalantaridis and Kuttim, 2021). Like traditional (narrative) reviews, SLRs summarize and synthesize the current state of knowledge in a given research topic or field, as well as identifying key weaknesses and opportunities for further research (Tranfield *et al.*, 2003; Weed, 2005; Petticrew and Roberts, 2008; Randolph, 2009). However, and in contrast to narrative reviews, wherein the analytical steps and procedures do not need to be documented, SLRs state in a clear manner the various stages, sampling criteria and method of analysis (Tranfield *et al.*, 2003; Weed, 2005; Petticrew and Roberts, 2008; Haddaway *et al.*, 2015).

Furthermore, and in contrast to other review methods (e.g., meta-analysis and meta-interpretive or ethnographic reviews) in which the underlying emphasis is on either quantitative or qualitative research (Weed, 2005; Randolph, 2009; Brannan *et al.*, 2017), SLRs often incorporate the findings of both quantitative (extensive) and qualitative (intensive) studies[8] (Doloreux and Porto Gomez, 2017; Compagnucci and Spigarelli, 2020). Because of their underlying methodological procedures, SLRs can review a much larger number of studies than can narrative reviews, albeit not in an entirely neutral manner (as the work of SLR practitioners implies) (Tranfield *et al.*, 2003; Petticrew and Roberts, 2008). As is the case with any form of scientific analysis, SLRs are theory-laden (Sayer, 2000b; Bhaskar, 2008); thus, their relevance and contribution are contingent upon the theoretical perspective that one takes. As a result of their eclectic nature, a major challenge that SLRs often face is how to synthesize key insights from a very large corpus of studies, especially when the findings are contradictory (Petticrew and Roberts, 2008). To overcome this challenge, this paper uses the review framework as the overall guide to the analysis.

Review sample: collection and analysis

The data in this SLR consist of 166 studies (the review sample)[9] published in 114 journals over the last three decades (1990–2019).[10] The review sample was identified through an iterative search in the Scopus database (https://www.scopus.com/). This database was chosen because it contains 50% more entries than other popular scholarly databases (e.g., Web of Science). A set of keywords was used (in the form of a Boolean equation) to identify the most relevant contributions. These included the following: innovation, technology, technological change, income, wage or earnings inequality, poverty, income distribution and distribution of income, wages and/or earnings. The first search, which was performed in the summer of 2019, identified 1,832 contributions. After excluding conference papers, papers published in predatory journals,[11] conceptual (including formal, mathematical modelling) papers, reviews, book chapters and editorials, as well as after scrutinizing the abstract section of each study for false positives (i.e., articles containing keywords that are relevant but not directly related to the subject), 166 peer-reviewed studies[12] met the following three inclusion criteria: being an empirical study (first inclusion criterion), published in English (second inclusion criterion) and available in a digital form (e.g., PDF) (third inclusion criterion).

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[8]Following Sayer (2000b) and other critical realist social scientists (e.g., Danermark *et al.*, 2002), this paper refers to qualitative research (e.g., grounded theory, case study research, ethnography, discourse analysis, etc.) as intensive, and to quantitative research (e.g., econometrics, advanced inferential statistics) as extensive. In the critical realist tradition, intensive and extensive research are seen as being both distinct and complementary (e.g., mixed method research) (Downward and Mearman, 2007).

[9]For a detailed overview of the sample, see Appendix.

[10]This is based on the earliest observation in the data.

[11]To do so, a list of predatory journals was used, which was retrieved from the following link: https://predatoryjournals.net/ (accessed September 2020).

[12]The sole focus on peer-reviewed studies is based on the assumption that peer-reviewed published studies often yield reliable and novel findings by applying advanced methodological standards (see Biggi and Giuliani, 2021).

In line with recent reviews on innovation (Doloreux and Porto Gomez, 2017; Compagnucci and Spigarelli, 2020), the review sample was analysed in a systematic manner by using a coding template (see Table 1). This consists of eleven codes. The first six codes (A to F) were developed in the early stages of the review (i.e., a priori coding), whereas the rest of the codes (G to M) emerged from the analysis (i.e., bottom-up coding) in the more mature stages of the review (King and Brooks, 2017). To establish the construct validity (Yin, 2009, p.34) of the coding template, three independent researchers were asked to use the coding scheme to analyse a sample of six studies. As illustrated in Table 1, a very high score of inter-coder reliability was achieved. Finally, following Cooper's (1988) taxonomy of literature reviews, the findings of this review are discussed in a chronological way. As will be shown in the next section, a chronological perspective offers a comparatively rich understanding of the disciplinary origins, development and major findings of three decades of research on innovation and inequality.

Innovation and inequality research: chronological review

One of the earliest observations in this review was that the number of published studies on innovation and inequality has, on average, risen by 220% every ten years (Figure 2). Even though this number suggests that research on innovation and inequality is growing at a much faster pace than that of research on other topics,[13] the growth in published research did not occur in a linear manner. For instance, while seven studies were published in 2001, this number drops to one study just one year later. Similarly, twelve studies were published in 2009, before this figure fell to six studies in 2010. To capture the ebbs and flows of research on innovation and inequality, the analysis distinguishes among three main research phases: the early phase (1990–9), the growth phase (2000–9) and the expansion phase (2010–19). The remainder of this section looks more closely at each phase, focusing on key aspects of research, such as bibliometric issues, fields of research, causal scenarios and explanatory themes.

Early phase (1990–1999)

BIBLIOMETRIC INSIGHTS

In the early phase, and unlike the subsequent two phases, research on innovation and inequality was extremely sparse, with less than one published study per year (Table 2). The paucity of research on innovation and inequality in the early phase reflects key events and developments in the domains of academia, economy and policy. For instance, the advent of free-market capitalism (in short, neoliberalism) as the dominant policy paradigm in the 1980s and 1990s systematically favoured academic discourse and theoretical perspectives that glorify the benefits of extensive economic growth (Harvey, 2005; Smith, 2010; Senker, 2015; Fotaki and Prasad, 2015; Albertson and Stepney, 2020), whereas the negative consequences of growth – such as rising inequality, social exclusion, mental health problems caused by job insecurity, excessive wealth concentration and environmental degradation (Pickett and Wilkinson, 2010; Breau and Essletzbichler, 2013; Sayer, 2015; Biggi and Giuliani, 2021) – were seen as secondary evils that sooner or later would be addressed, in the most efficient manner possible, through the undisturbed operation of (global) markets (Harvey, 2005; Fotaki and Prasad, 2015; Senker, 2015; Albertson and Stepney, 2020). In this context, rising inequality was, initially, seen as a temporary anomaly of the liberal market economies of the US and UK, rather than a general socioeconomic challenge that concerns all market economies equally (Freeman, 2001; Hall and Soskice, 2001; Lundvall, 2002; Piketty, 2014; Dorling, 2019).

Research in the 1990s was ascetic, being based mainly on single author contributions. While single-author contributions were endemic in published research on innovation in the 1990s

[13]For instance, bibliometric studies show that the number of published research papers doubles in size every 10–15 years (Bornmann and Mutz, 2015).

Table 1. Coding template

Code	Label	Description	Illustration based on Aghion *et al.* (2019)	Intercoder agreement (%) *
A	Author(s)	Full name of author(s)	Philippe Aghion, Ufuk Akcigit, Antonin Bergeaud, Richard Blundell and David Hemous	100
B	Year	Year of publication	2019	100
C	Title	Title of publication	'Innovation and top income inequality'	100
D	Journal	Journal of publication	*Review of Economic Studies*	100
E	Field	Primary field(s) to which the journal belongs (based on the journal's description)	Economics: 'The *Review of Economic* Studies is a quarterly peer-reviewed academic journal covering economics' (source: https://www.restud.com/)	100
F	Keywords	Authors' keywords	top income, inequality, innovation, patenting, citations, social mobility, incumbents, entrant	100
G	Research context	Country	United States	100
H	Primary research unit	Individuals, employees, households, firms, sectors, cities, regions, countries	Individuals, metropolitan regions: 'we use cross-state panel and cross-US commuting-zone data' (Aghion *et al*., 2019, p.1)	100
I	Research design	Extensive (quantitative) research, intensive (qualitative) research or mixed (both)	Extensive (regression): 'We start our empirical analysis by exploring correlations between innovation and various measures of inequality using OLS regressions*.'* (Aghion *et al.,* 2019, p.3)	100
J	Measure of innovation	Patent intensity, R&D investments, types of innovation etc.	Patents: 'In our empirical analysis, we shall regress top income shares on innovation. Our innovation measure is based on the number of patents per capita' (Aghion *et al*., 2019, p.2)	100
K	Measure of inequality	Gini index, Theil index, percentiles etc.	Percentiles, Gini, Atkinson index: 'Percentiles are computed from the national income distribution.' (Aghion *et al.*, 2019, p.38)	100
L	Causal scenario	There is no causal relationship (scenario 0), innovation induces inequality (scenario I), inequality is positively associated with innovation (scenario II), innovation ameliorates inequality (scenario III), inequality affects innovation negatively (scenario IV)	Causal scenario I: 'we found a positive and significant correlation between innovation and top income inequality' (Aghion *et al.,* 2019, p.41)	100
M	Explanatory factor(s)	Key factors and determinants that explain the direction of causality	'entrants' and incumbents' innovation increase top income inequality' (Aghion *et al.,* 2019, p.2)	100
Average intercoder agreement				100

*Average score based on the assessment of three intercoders
Source: own elaboration, Scopus

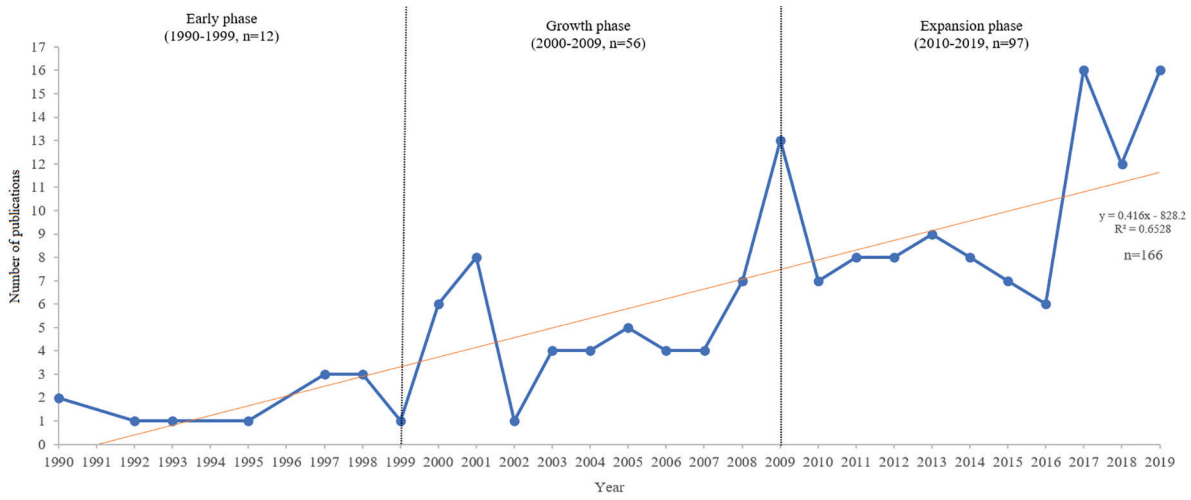

Figure 2. Publications by year

Source: own elaboration, Scopus

(see, for instance, table 1 in Martin, 2012), the early work was highly cited (302 citations per study). The three most cited studies (i.e., Krueger, 1993; Bernard and Jensen, 1997; Bresnahan, 1999) were published in (mainstream) economic journals.[14] Although the number of citations is by no means a reliable indication of scholarly novelty and quality (Macdonald and Kam, 2011; MacRoberts and MacRoberts, 2018), it nonetheless implies that mainstream economic research has, in one way or another, been highly influential, constituting either an impetus for further research or an object of critique (e.g., Card and DiNardo, 2002; Autor *et al.*, 2008; Lazonick and Mazzucato, 2013; Avent-Holt and Tomaskovic-Devey, 2014; Hanley, 2014). However, as is shown in Table 2, development studies scholars and employment relations scholars were also very active in the 1990s. Thus, unlike previous stock-taking assessments (e.g., Acemoglu, 2002; Acemoglu and Autor, 2011), which give the impression that only mainstream labour economists have investigated the relationship between technological innovation and inequality, research appears to have, from the outset, been significantly more discipline-diverse than previously thought.

RESEARCH CONTEXT, DESIGN, MEASURES AND UNITS OF ANALYSIS

More than 60% of all studies in the 1990s were concerned with the US and UK (Krueger, 1993; Chennells and Reenen, 1998; Bresnahan, 1999), whereas 40% of all studies examined developing countries, such as Indonesia (James and Khan, 1998), Nepal (Thapa *et al.*, 1992) and the Philippines (Otsuka *et al.*, 1990). The focus on the US and the UK can be associated with the fact that most researchers are affiliated with academic organizations in these countries. Innovation was gauged by using narrow measures (e.g., computer usage and R&D intensity) (Krueger, 1993; Machin, 1998), and inequality by utilizing the following measures: percentiles, Gini index and wage gaps (e.g., Thapa *et al.*, 1992; Krueger, 1993; Machin, 1998). More than 92% of studies were extensive, using econometrics and advanced inferential methods, with only one study (Gray *et al.*, 1998), which was published in a heterodox economics journal (*Review of Radical Political Economics*), using a mixed-method research design. Although no specific methodological reason is stated in all studies under review for the wide use of extensive research designs, this could be linked to the fact that 75%

[14]To distinguish between mainstream and heterodox economic journals, Cronin's (2020) list of economic journals was used (available at https://www.hetecon.net/resources/ journal-rankings/).

Table 2. Early phase

	1990–1999 (n=12)
No. of published studies per year	0.83
No. of authors per study	1.04
Citations per study*	305
% of studies reporting financial support	16
Most active donors by country	National Science Foundation, Dutch Research Council (NWO)
Affiliation (country) of most authors	US, UK, Netherlands, Germany, Japan
Most used keywords	Income distribution, income inequality, technological change, labour market, Europe, Asia
Journals	*Agricultural Economics, Economic Journal, Economics of Innovation and New Technology, Journal of International Economics, Metroeconomica, National Institute Economic Review, Quarterly Journal of Economics, Review of Radical Political Economics, Work and Occupations, World Development*
Most active fields	Economics, development studies, employment relations
Popular research context	US, UK
Most used research design	Extensive
Most used unit of analysis	Employees, individuals, sectors, countries
Most used measure(s) of innovation	Computer usage, R&D intensity, specific technologies
Most used measure(s) of inequality	Percentiles, Gini index, wage gap
Most observed causal scenarios	Innovation induces inequality (causal scenario I), absence of causality (causal scenario 0), innovation reduces inequality (causal scenario III), inequality positively affects innovation (causal scenario II)
Recurrent explanatory factors	Skill premiums (Krueger, 1993; Bernard and Jensen, 1997; Bresnahan, 1999)

*based on Google Scholar, July 2020
Source: own elaboration, Scopus

of all studies in the 1990s were published in economics journals.[15] Employees and individuals are the primary unit of analysis, followed by sectors and countries (cross-country analysis). This, among other things, reveals that, since the beginning, researchers have assumed that the relationship between innovation and inequality is a multilevel one.

CAUSAL SCENARIOS AND EXPLANATORY FACTORS

The majority of studies (approximately 58%) find that innovation induces inequality (causal scenario I) (e.g., Krueger, 1993; Bresnahan, 1999), while 25% opined that there is no causal connection between innovation and inequality (causal scenario 0) (e.g., Colclough and Tolbert, 1990, Otsuka *et al.*, 1990; Freebairn, 1995). The remaining studies (17%) imply either that inequality can positively affect innovation (causal scenario II) (e.g., Falkinger and Zweimuller, 1997) or that innovation reduces¨ inequality (causal scenario III) (e.g., James and Khan, 1998).

Causal scenario I is mainly attributed to the skill-biased character of technological innovation in general, and to the skill premium mechanism in particular (Krueger, 1993; Bernard and Jensen, 1997; Chennells and Reenen, 1998; Bresnahan, 1999). Krueger (1993), for instance, provides evidence suggesting that US workers who use computers at work earn, on average, 10 to 15%

[15]It goes without saying that, unlike the work of classical economists, including the work of other influential economists (e.g., Thorstein Veblen, Werner Sombart, Max Weber, Joseph Schumpeter), modern economists – regardless of being mainstream or heterodox – believe, in one way or another, that econometrics is the most scientifically legitimate method of studying the economic world (Lawson, 1997; Lazear, 2000; Louca, 2007).

higher wages. Regarding the possibility that innovation and inequality are not causally related (causal scenario 0), which is the second most popular in the early phase, research does not identify recurrent explanatory factors.

Nonetheless, studies falling within causal scenario 0 raise some interesting questions about the skill-biased technological change hypothesis. For instance, Bernard and Jensen (1997) provide firm-based evidence confirming that while international trade has increased the demand for white-collar labour in US manufacturing plants, it had no significant impact on the wage gap among white- and blue-collar workers (see also Machin, 1998). Additionally, the analysis of Colclough and Tolbert (1990) raises the possibility that the skill-biased character of technological change may favour the skills, marginal productivity and wages of privileged social groups and actors (e.g., educated, native white men) (see also Echeverri-Carroll *et al.*, 2018; ten Berge and Tomaskovic-Devey, 2021). As will be shown throughout this review, economic studies have paid very little attention to the horizontally biased (i.e., gender and racially biased) character of skill premiums.

Growth phase (2000–2009)

BIBLIOMETRIC INSIGHTS

As is the case with the early phase, research in the growth phase consists mainly of single-authored publications: 1.1 authors per study (Table 3). However, unlike the early phase, the number of published studies per year increased tremendously: from 0.8 studies per year to 5.6 studies per year. This can, among other issues, be attributed to a growing interest in the causes and consequences of rising inequality (Neckerman and Torche, 2007; Kim and Sakamoto, 2008; Pickett and Wilkinson, 2010; Cavanaugh and Breau, 2018). Similarly, vivid discussions among mainstream labour economists of the skill-biased character of technological innovation (e.g., Krusell *et al.*, 2000; Card and DiNardo, 2002; Autor *et al*., 2008), including debates on the impact of international trade and declining union membership upon inequality (Belman and Monaco, 2001; Card and DiNardo, 2002; Autor *et al.*, 2003; Mosher, 2007; Adams, 2008; Autor *et al.*, 2008; Meschi and Vivarelli, 2009), prompted further research on innovation and inequality in the growth phase.

REGARDING FIELDS

No significant change was observed other than that the field of employment relations is the second most active, while the fields of economics and development studies are first and third, respectively. This disciplinary division of research is also reflected in the most popular journals in the period under consideration (e.g., *World Development, Journal of Development Economics, Industrial Relations, Labour, Economics of Transition, International Review of Applied Economics, Review of Economics and Statistics, and Industrial and Labor Relations Review*). Thus, as is the case with research in the early phase, it is mainly non-economics journals that provided important fora for researchers on innovation and inequality in the growth phase.

RESEARCH CONTEXT, DESIGN, MEASURES AND UNITS OF ANALYSIS

Research in the 2000s examined such countries as Australia (e.g., Gibson, 2003), China (Wei *et al.*, 2001), Chile (Alvarez and Lopez, 2009), Colombia (e.g., Attanasio *et al*., 2004), India (e.g., Kijima, 2006), Germany (e.g., Dustmann *et al.*, 2009), Mexico (e.g., Esquivel and Rodrıguez-Lopez, 2003), the Netherlands (e.g., Bruinshoofd *et al.*, 2001) and South Korea (Xu and Li, 2008). However, the Anglo-Saxon trinity (the US, UK and Canada) was central to the analysis in most studies (55% of all studies). As in the early phase, this could be related to the affiliation of authors, including the location of the most active funding donors (see Table 3).

The great majority of studies (95%) were extensive, with the remaining studies (5%) using a mixed-method design (e.g., Cozzens *et al*., 2002; Mukhopadhyay and Nandi, 2007). As with research in the early phase, no study adopts an intensive research design, such as grounded theory,

Table 3. Growth phase

	2000–2009 (n=56)
No. of published studies per year	5.6
No. of authors per study	1.1
Citations per study*	219
% of studies reporting financial support	14.3
Most active non-academic donor (country)	National Science Foundation (US), Deutsche Forschungsgemeinschaft (Germany)
Affiliation (country) of most authors	US, UK, Canada, Italy, Germany, Portugal, China, Japan and South Korea
Recurrent keywords	Income distribution, technological change, United States, North America, skilled labour, labour market, wage gap, wage inequality, wages, innovation
Most preferred journals	*World Development, Journal of Development Economics, Industrial Relations, Labour, Economics of Transition, International Review of Applied Economics (HE), Review of Economics and Statistics, Industrial and Labor Relations Review*
Most active fields	Economics, employment relations, development studies,
Most chosen research context	US, UK, cross-country, Canada, Germany
Popular research designs	Extensive, mixed
Most preferred units of analysis	Individuals, sectors, countries, employees, firms
Most used measure(s) of innovation	Latent variable, computer usage/intensity, R&D expenditure, technology, product and process innovation, exports
Most used measure(s) of inequality	Percentiles, Gini index, income and wage gaps, Theil index
Causal scenarios	Innovation induces inequality (scenario I), absence of causality (scenario 0), inequality positively affects innovation (scenario II), innovation reduces inequality (scenario III), inequality hinders innovation (scenario IV)
Recurrent explanatory factors	Skill premiums (Krusell *et al.,* 2000; Fernandez, 2001), international trade (Baldwin and Cain, 2000; Attanasio *et al.,* 2004; Choi and Jeong, 2005; Xu and Li, 2008), geographical aspects (e.g., Pastor and Marcelli, 2000; Wheeler, 2005; Hudson, 2006; Taylor, 2006; Kijima, 2006; Echeverri-Carroll and Ayala, 2009), horizontal inequality (e.g., Mukhopadhyay and Nandi, 2007), innovation policy (e.g., Langer, 2001, Cozzens *et al.*, 2002; Attanasio *et al.*, 2004; Hudson, 2006; Donegan and Lowe, 2008; Weinhold and Nair-Reichert, 2009), declining union membership (e.g., Belman and Monaco, 2001; Mosher, 2007), digital gaps (e.g., Gibson, 2003; Chakraborty and Bosman, 2005; Fuchs, 2009), organizational practices (Black *et al.,* 2004; Handel and Gittleman, 2004).

*based on Google Scholar, July 2020
Source: own elaboration, Scopus

case study research and/or ethnography. This, among other issues, implies that the great majority of researchers in the growth phase see extensive research as ideal in distinguishing what is causal from what is not in the relationship between innovation and inequality. As will be discussed in the concluding section of this paper, the methodological monopoly of extensive research has a number of crucial epistemological consequences for both explanatory research and policy design.

One out of three studies (34%) analyses micro-units (e.g., individuals and employees) (e.g., Krusell *et al.*, 2000; McCall, 2000; Englehardt, 2009), while the remainder (64%) focus on the meso-level (e.g., sectors, firms, cities and villages) and/or the macro-level (e.g., countries) (e.g., Kijima, 2006; Bogliacino, 2009; Echeverri-Carroll and Ayala, 2009; Fuchs, 2009; Weinhold and Nair-Reichert, 2009). Thus, unlike research in the 1990s, the more recent research has used sectors

and firms as the primary unit of analysis. One possible explanation for this is the availability of firm-level and sectoral data in the 2000s owing to the wide circulation of international (firm-based) surveys on innovation (e.g., *Community Innovation Survey*) (Smith, 2005; Hong *et al.*, 2012). Nonetheless, innovation is measured in a narrow manner (e.g., computer usage, R&D intensity, patents) (e.g., Xu and Li, 2008; Weinhold and Nair-Reichert, 2009), with only a very small portion of studies using alternative measures, such as the percentage of high-tech employment (e.g., McCall, 2000; MacPhail, 2000), indicators of product and process innovation (e.g., Angelini *et al.*, 2009; Bogliacino, 2009). Additionally, and in line with several studies in the early phase, 25% of all studies treat innovation either as a latent (background) causal factor (e.g., Wheeler, 2005; Kim and Sakamoto, 2008; Xu and Li, 2008; Dustmann *et al.*, 2009) or as export intensity (e.g., Meschi and Vivarelli, 2009). However, since these measures explain very little about the actual nature of innovation (Smith, 2005), several questions are raised as to the construct validity and explanatory power of research in the growth phase. For the measurement of inequality, percentiles (e.g., Cozzens *et al.*, 2002; Kijima, 2006; Borghans and Ter Weel, 2007), the Gini index (e.g., Langer, 2001; Kim and Sakamoto, 2008; Adams, 2008), income and wage gaps (Krusell *et al.,* 2000; McCall, 2000; Bogliacino, 2009) were used widely. The Theil index was also used in some studies (e.g., Cozzens, 2003; Meschi and Vivarelli, 2009) either on its own or in conjunction with other measures, mainly for robustness check purposes.

CAUSAL SCENARIOS AND EXPLANATORY FACTORS

In line with research in the early phase, 70% of all studies in the expansion phase confirm that innovation induces inequality (causal scenario I) (e.g., Krusell *et al*., 2000; Bogliacino, 2009; Echeverri-Carroll and Ayala, 2009; Wheeler, 2005), whereas the remaining 30% is divided between the rest four causal possibilities: 9% suggest that there is no causality between innovation and inequality (causal scenario 0) (e.g., Brown and Campbell, 2001; Handel and Gittleman, 2004; Belman and Levine, 2004); 8% of studies point out that inequality has a positive impact on innovation (causal scenario II) (e.g., Chakraborty and Bosman, 2005; Englehardt, 2009); 8% has a negative effect on innovation (causal scenario IV); lastly, 5% opine that innovation lessens inequality (e.g., Gibson, 2003; Martin and Robinson, 2007; Mukhopadhyay and Nandi, 2007). In short, as is the case with research in the early phase, the great majority of studies in the growth phase suggest that innovation induces inequality.

Causal scenario I is mainly attributed to skill premiums caused by technological innovation (e.g., Krusell *et al.*, 2000; Wheeler, 2005; Commander and Kollo, 2008; Englehardt, 2009), whereas another much smaller, albeit highly cited, number of studies propose and substantiate empirically the task-biased version of the skill-biased technological change hypothesis, wherein innovation leads to income polarization through skill premiums and technological unemployment mechanisms (e.g., Autor *et al.*, 2003, 2008). Another strand of research suggests that skill premiums are sector-specific (e.g., high-technology sectors) and geographically confined, occurring mostly in high-technology sectors and regions (Cozzens, 2003; Wheeler, 2005; Florida, 2007; Angelini *et al.*, 2009; Bogliacino, 2009; Doussard *et al*., 2009; Echeverri-Carroll and Ayala, 2009). For instance, Echeverri-Carroll and Ayala (2009) find that employees in US cities with a high-technology industry earn, on average, 17% higher salaries than employees in other regions.

Other studies examine the interaction between skills and international trade in both developed and developing countries (Haskel and Slaughter, 2001; Esquivel and Rodrıguez-Lopez, 2003; Attanasio *et al.*, 2004; Baldwin and Cain, 2000; Kijima, 2006; Xu and Li, 2008; Bogliacino, 2009; Meschi and Vivarelli, 2009). The findings of these studies lead to two contradictory conclusions. On the one hand, it is skill-biased technological change, rather than international trade *per se*, that leads to inequality via the skill premiums mechanism (e.g., Commander and Kollo, 2008). On the other hand, the complementary dynamics among innovation, international trade and organizational factors (e.g., the ownership structure of innovative firms) trigger export-induced skill premiums (e.g., Xu and Li, 2008; Bogliacino, 2009).

In addition to the above, non-economic studies show that skill premiums have a strong horizontal dimension (MacPhail, 2000; Fernandez, 2001; Taylor, 2006). Fernandez (2001), for instance, finds that the adoption of technological innovation in a US food firm led to 'greater racial inequalities in wages' (Fernandez, 2001, p.273). Another line of research raises the possibility that skill premiums may also be induced by such non-market forces as policies, especially policies (a) aimed at boosting high-technology employment and growth in regions (Cozzens *et al.*, 2002; Mukhopadhyay and Nandi, 2007), or (b) reinforcing the intellectual property rights regime (Adams, 2008; Arndt *et al*., 2009). A relatively small number of mainly employment relations studies (Belman and Monaco, 2001; Brown and Campbell, 2001; Black *et al.*, 2004; Handel and Gittleman, 2004; Mosher, 2007; Doussard *et al.,* 2009) underline that the ability of innovation to induce inequality is subject to both institutional (e.g., declining union membership and collective wage bargaining) and organizational factors (e.g., new employment practices). Belman and Monaco (2001), for instance, show that, thanks to labour market deregulation, the use of advanced technologies (e.g., satellite communication systems) led to a reduction of 21% in the wages of US truck drivers in the 1990s. Lastly, Black *et al.* (2004) find that new flexible employment practices (e.g., job rotation) are associated with lower employment reductions but higher wage inequality (cf. Handel and Gittleman, 2004).

Regarding the second most observed causal possibility (i.e., absence of causality, causal scenario 0), research in the growth phase provides no clear insight in terms of recurrent explanatory factors. Nonetheless, some of these studies offer a few interesting insights into the explanatory validity of the skill premiums hypothesis. For instance, Kim and Sakamoto (2008) find in their analysis of US manufacturing industries that the adoption of radical technological innovation at work increased wage inequality but not labour productivity as the skill-biased technological change account assumes (Acemoglu and Autor, 2011); in short, skill premiums do not necessarily reflect human capital factors, such as higher labour productivity (see also Hanley, 2014; Tomaskovic-Devey and Avent-Holt; 2019). Other studies (Mishel and Bernstein, 2003; Borghans and Ter Weel, 2007; Xu and Li, 2008) suggest that, since wage inequality has not risen to the same extent in all countries (e.g., OECD, 2015; Kawaguchi and Mori, 2016), the inequality-inducing abilities of innovation (e.g. skill premiums and technological unemployment) seem to be significantly curtailed by non-market factors such as employment strategies, organizational structures and national institutional arrangements (e.g., Card and DiNardo, 2002; Belman and Levine, 2004; Goos *et al*., 2014; Hanley, 2014; Boyer, 2015; Kawaguchi and Mori, 2016; Croce and Ghignoni, 2020; Tomaskovic-Devey and Avent-Holt, 2019).

Regarding the remaining causal possibilities, namely that inequality stimulates innovation (causal scenario II), inequality hinders innovation (causal scenario IV) and innovation reduces inequality (causal scenario III), research in the growth phase is not especially illuminating. An exception is a few studies that investigate the relationship between existing socioeconomic inequality and the diffusion of innovation (e.g., Gibson, 2003; Chakraborty and Bosman, 2005; Martin and Robinson, 2007). Following this (mainly non-economic) line of research, it seems that existing horizontal inequalities adversely affect the ability of marginalized actors to participate in and take advantage of (digital) innovation activities (Gibson, 2003; Cozzens and Kaplinsky, 2009; Fuchs, 2009; Vona and Patriarca, 2011). Gibson (2003), for instance, examines the use of information and communication technologies (ICT) in Australia. Using data gathered by Australia's national census, the author identifies a significant digital gap among households and territories in Australia. Similarly, like Martin and Robinson's (2007) analysis in the US, as well as Mendonça *et al.*'s (2015) analysis in Portugal, Chakraborty and Bosman (2005) indicate that digital inequality has a persistent horizontal dimension in the US: 'while income inequalities among PC owners (households) decreased between 1994 and 2001 in all regions and states, the magnitude of this inequality has declined more rapidly among white households compared to African Americans' (Chakraborty and Bosman, 2005, p.395). Overall, research in the growth phase identifies several recurrent explanatory factors in most causal scenarios. As will be shown shortly, research in the expansion phase has, in general, moved along similar lines.

Expansion phase (2010–2019)

BIBLIOMETRIC INSIGHTS

As with the growth phase, the expansion phase exhibits a significant increase in publications, from 5.6 studies per year to 9.7 studies per year (Table 4). This could be associated with the occurrence of social movements (e.g., Occupy Wall Street and We Are the 99%), including the global financial crisis and the striking income inequalities (e.g., excessive pay compensation packages and bonuses) that were brought to light (Blankenburg and Palma, 2009; Crotty, 2009; Sayer, 2015). All of these have triggered further debates and research on the underlying causes and consequences of inequality (Pickett and Wilkinson, 2010; Stiglitz, 2012; Breau and Essletzbichler, 2013; Bapuji, 2015; Arestis, 2020).

Number of authors per study increases from 1.1 to 1.9. On the one hand, this reflects the broader trend among innovation researchers towards collaboration (Fagerberg *et al.,* 2012; Martin, 2012). On the other hand, this implies that conducting and publishing research on innovation and inequality have become more demanding and time-consuming than previously. Nonetheless, the number of citations per study is lower than in the previous two phases at 118. Arguably, this could be attributed to older studies being more likely than recently published ones to have more citations. Of importance is also the fact that, unlike in the previous two phases, wherein, on average, only 15% of published studies received financial support, more than 32% of published studies were sponsored by academic organizations, think tanks and policy organizations, with the most active non-academic donors being located in the UK (e.g., Economic and Social Research Council, UK Research and Innovation), Europe (e.g., European Commission), the US (e.g., National Science Foundation) and South Korea (National Research Foundation of Korea). Although an in-depth analysis of the power issues and dynamics between sponsors and researchers is beyond the scope of this paper, it is important to mention that external funding activities seem to have reinforced, albeit not necessarily intentionally, certain disciplinary discourses and types of research in the expansion phase, such as the research focus on skill premiums, few countries and research methods (see Table 4).

RESEARCH FIELDS

As for research fields, a significant reshuffle occurred in the expansion phase. Unlike in the growth phase, where the fields of economics, development studies, and employment relations were the three most active, the fields of economics, innovation studies, geography and sociology are the first, second, third and fourth most active in the post-2010 period, respectively. The emergence of innovation studies journals (e.g., *Technological Forecasting and Social Change, Industrial and Corporate Change*), geographical journals (e.g., *Regional Studies*) and sociological journals (e.g., *American Behavioral Scientist*, *American Sociological Review*) in the list with the most preferred journals is illustrative of this trend.

However, a closer examination of published studies in these journals reveals several important insights and critical observations. Specifically, while at first sight it appears that innovation studies researchers have begun to pay some serious attention to inequality (see, for instance, Faggio *et al.*, 2010, Lazonick and Mazzucato, 2013), the rise in published innovation research is attributable to guest editorials (e.g., Coad *et al.*, 2021; Cozzens, 2012) rather than to independent studies. This, among other issues, raises important questions as to the role that the peer review mechanism might play in shaping the research agenda in the field (Macdonald, 2015; Martin, 2016). Questions are also raised with regard to the absence of the flagship journal of the field of innovation studies (i.e., *Research Policy*) and *Prometheus* from the list of the most active journals. This is quite surprising because both journals seek, by tradition, to publish critically minded research on innovation (Cozzens, 2003; Fagerberg *et al*., 2012). Judging from this situation, it seems that, unlike the work of the founding figures of the field (e.g., Christopher Freeman, Dick Nelson and Bengt-Ake Lundvall), where economic and societal challenges (e.g., jobless growth, social inclusion and technological unemployment) figured prominently (e.g., Archibugi and Lundvall, 2001; Lundvall, 2002; Fagerberg *et al.*, 2011), the great majority of contemporary innovation researchers seem to be

Table 4. Expansion phase

	2010–2019 (n=97)
No. of published studies per year	9.7
No. of authors per study	1.9
Citations per study*	116
% of studies reporting financial support	32
Most active non-academic donors (country)	Economic and Social Research Council (UK), European Commission (Belgium), National Research Foundation of Korea (Korea), National Science Foundation (US), UK Research and Innovation (UK)
Affiliation (country) of most authors	US,UK, Canada, Italy, Germany
Most used keywords	Income distribution, wage gap, technological change, innovation, information and communication technology, skilled labour, labour market, United States
Most preferred journals	*American Behavioral Scientist, American Economic Journal: Macroeconomics, Applied Economics, American Sociological Review, Applied Economics Letters, Industrial and Corporate Change, Journal of Economic Issues, Journal of the European Economic Association, Regional Studies, Review of Development Economics, Scandinavian Journal of Economics, Social Indicators Research, Technological Forecasting and Social Change, World Development*
Most active fields	Economics, innovation studies, geography and sociology
Most used research context	Cross-country, US, UK, Canada, European Union
Most used research designs	Extensive
Most preferred units of analysis	Individuals, countries, employees, cities and regions
Most used measure(s) of innovation	Latent variable, R&D expenditure, patents, high-tech employment, employment in knowledge-intensive business services, ICT investments
Most used measure(s) of inequality	Gini index, percentiles, wage/income gap, gender gap, Theil index
Causal scenarios	Innovation induces inequality (zcenario I), inequality positively affects innovation (scenario II), inequality hinders innovation (scenario IV), innovation reduces inequality (scenario III), and absence of causality (scenario 0)
Recurrent explanatory factors	Skill premiums (Goos *et al*., 2014; Adermon and Gustavsson, 2015), trade (Almeida and Afonso, 2010; Jaumotte *et al*., 2013; Juhn *et al*., 2014), technological unemployment (Frey and Osborne, 2017), geographical aspects (Lee, 2011; Consoli et al., 2013; Breau *et al*., 2014; Florida and Mellander, 2016; Otioma *et al*., 2019), digital gap (Hilbert, 2010), horizontal inequality (Brouwer and Brito, 2012; Brynin and Perales, 2016; Juhn *et al.*, 2014; Echeverri-Carroll *et al.*, 2018; Cheng *et al*., 2019), deunionization (Kristal, 2013; Kristal and Cohen, 2017; Stockhammer, 2017), innovation policy (Cozzi and Impullitti, 2010; Lee, 2019), organizational factors (Hanley, 2014), types of innovation (Thakur, 2012; Richmond and Triplett, 2018)

Source: own elaboration, Scopus
*based on Google Scholar, July 2020

interested in conducting research that primarily reflects the interests of a few select actors (e.g., elite scholars and policymakers) rather than society as a whole (see also Martin, 2016).

Geographers have also been quite active in the expansion phase, publishing several well-conducted studies (e.g., Lee, 2011; Consoli *et al.*, 2013; Lee and Rodrıguez-Pose, 2013; Breau *et al.*, 2014; Guo, 2019; Otioma *et al.,* 2019). However, by investigating mainly cities and regions in the US (Lee and Rodrıguez-Pose, 2013), Europe (Lee, 2011; Tselios, 2011) and Canada (Breau *et al.*, 2014), geographical research has extended, yet intensified, our knowledge of a few English-speaking countries (e.g., the US, the UK and Canada). While the choice to investigate a certain group of cities and regions over others is determined by data availability (e.g., Lee, 2011; Tselios,

2011), the fact that several geographical studies in the expansion phase received financial support from organizations based in the UK and Europe also seems to have played a role.

Despite being 'too late to join the party', sociological studies have looked mainly at the relationship between innovation and inequality in the US. (e.g., Fernandez, 2001; DiPrete, 2007; Kristal, 2013; Hanley, 2014; Kristal and Cohen, 2017). However, unlike most innovation and geographical studies, which seem to have uncritically adopted the underlying assumptions and hypotheses of the skill-biased technological change account (e.g., Wheeler, 2005; Lee, 2011; Breau *et al.*, 2014; Cirillo *et al.*, 2021), sociological studies tend to problematize, criticize and empirically illustrate that the account in question, including its variants, is misleading and handicapped (e.g., Fernandez, 2001; Kristal, 2013; Hanley, 2014; Kristal and Cohen, 2017). Yet another emerging line of sociological research seeks to develop an alternative explanatory account based on relational inequality theory (Avent-Holt and Tomaskovic-Devey, 2014; Hanley, 2014; Vallas and Cummins, 2014). Nonetheless, despite being equipped with a sophisticated theory of income distribution as a relational-organizational phenomenon (Avent-Holt and Tomaskovic-Devey, 2014; Tomaskovic-Devey, 2014), this sociological line of research lacks – as is the case with SBTC research – an appropriate theory of innovation (see also Lazonick and Mazzucato, 2013; Fragkandreas, 2021).

RESEARCH DESIGNS AND MEASURES

Research in the expansion phase is characterized by the excessive use of extensive research designs and methods (97% of all studies), with only 3% of all studies adopting intensive research designs and mixed methods (e.g., Brouwer and Brito, 2012; Hanley, 2014; Thakur, 2012; Woodson *et al.*, 2019). This, among other things, implies that innovation scholars and geographers have added very little methodological novelty and variety. Regarding the measurement of innovation, and in line with research in the growth phase, 20% of all studies treat innovation as a background variable (e.g., Kawaguchi and Mori, 2016; Echeverri-Carroll *et al.*, 2018; Antonczyk *et al.*, 2018; Frey and Osborne, 2017), while the remaining 80% use various measures. These include patents (e.g., Lee, 2011, Antonelli and Gehringer, 2017, Aghion *et al*., 2019), R&D intensity (Almeida and Afonso, 2010; Hatipoglu, 2012; Cirillo *et al.*, 2017), high-technology employment (Lee, 2011; Mehic, 2018; Hope and Martelli, 2019), ICT investments and usage (e.g., Broccolini *et al.*, 2011; Shahabadi *et al.*, 2017) and concrete cases and types of innovations (e.g., Santos *et al.*, 2017; Woodson *et al.*, 2019).

As for the measurement of inequality, no significant change is registered; besides, some studies use two new (to this research field) measures, namely the Atkinson index (e.g., Lee, 2011) and the Palma ratio (e.g., Mehic, 2018). The remaining studies deploy the usual measures, such as the Gini index (Antonelli and Gehringer, 2017), income gaps among groups (e.g., Cheng et al., 2019), percentiles (e.g., Hope and Martelli, 2019) and Theil index (e.g., Tselios, 2011; Hatipoglu, 2012; Breau *et al*., 2014). These measures are deployed either individually or in concert (e.g., Lee, 2011; Breau *et al*., 2014; Cirillo *et al*., 2017) for construct validity purposes.

CAUSAL SCENARIOS AND EXPLANATORY FACTORS

Echoing the findings of research in the previous two phases, the great majority of studies (72%) confirm that innovation induces inequality (causal scenario I) (Almeida and Afonso, 2010; Breau *et al*., 2014; Santos *et al.*, 2017; Comin and Mestieri, 2018; Hope and Martelli, 2019). However, unlike in the previous two phases, wherein the absence of causality (causal scenario 0) was the second most observed causal possibility, the second most observed causal scenario (12% of studies) in the expansion phase is that inequality negatively impacts innovation (causal scenario IV) (e.g., Vona and Patriarca, 2011; Hatipoglu, 2012; Otioma *et al.,* 2019; Hilbert, 2010). The remaining studies (16%) find that inequality benefits innovation (causal scenario II) (e.g., Hyytinen and Toivanen, 2011; Tselios, 2011) or that innovation lessens inequality (causal scenario III) (e.g., Dell'Anno and Solomon, 2014; Antonelli and Gehringer, 2017; Shahabadi *et al*., 2017), while only 5% indicate that there is no significant causality between innovation and inequality (causal scenario 0) (e.g., Ding *et al.*, 2011; Bonjean, 2019; Croce and Ghignoni, 2020).

Regarding popular explanatory factors, no significant change is noticed: causality in its various forms is related to the same explanatory factors as in the growth phase (for more information, see Table 4). However, and unlike in the previous two phases in which the great majority of studies assessed the (statistical) impact of a few explanatory factors (in the form of independent variables), a number of studies in the expansion phase consider competing or alternative explanations for causal scenario I (e.g., Almeida and Afonso, 2010; Jaumotte *et al.*, 2013; Lin and Tomaskovic-Devey, 2013; Kristal, 2013; Kristal and Cohen, 2017; Stockhammer, 2017). For instance, Kristal (2013) and Kristal and Cohen (2017) provide evidence that rising inequality in the US is primarily driven by workers' disempowerment rather than by skill premiums associated with technological change (e.g., Acemoglu *et al.*, 2001). Thewissen *et al.* (2018) extend this finding by exploring the drivers of earnings inequality at the sectoral level in eight OECD countries. The findings 'provide mixed evidence for the hypothesis that skill-biased technological change increases earnings inequality' (p.1023). On the contrary, Thewissen *et al.* (2018) show that waning labour union power is an important driver of earnings inequality in the countries under investigation. Similarly, in their study of 109 developing and developed countries, Richmond and Triplett (2018) confirm that the causal association between innovation and inequality is conditioned not only by types of innovation (e.g., product or process innovation) and sectoral technological intensity (see also Angelini *et al.*, 2009; Broccolini *et al.*, 2011), but also by the economic and political characteristics of each country (see also Dell'Anno and Solomon, 2014; Iversen and Soskice, 2015; Goel, 2017; Antonczyk *et al.*, 2018). As will be discussed in the concluding section, identifying concrete configurations of causal factors (i.e., causal mechanisms) that enable (or constrain) certain types of innovation to induce (or reduce) inequality in certain places (e.g., cities, regions and nations), but not in others, constitutes a promising research opportunity.

Concluding discussion: findings, knowledge gaps, implications and limitations

Main findings

This paper is among the first to identify and review in a critical, systematic manner the extant stock of knowledge on innovation and inequality in various fields of social science. Driven by a novel analytical framework, the analysis yields several novel findings and critical observations. Specifically, and in line with previous reviews (Acemoglu, 2002; Bogliacino, 2014; Lee, 2016), including research on skill-biased technological change (STBC) (Acemoglu and Autor, 2011), the present review confirms that most studies (approximately 71%) find that innovation induces inequality in contemporary capitalist societies (causal scenario I). However, and in contrast to previous reviews, including SBTC research, it was shown that a considerable number of studies (approximately 30%) point to four other causal possibilities (see Table 5). In short, there is much more to be understood about causality in the relationship between innovation and inequality than research on SBTC has assumed.

Important also is the fact that, unlike previous contributions that cultivate the impression that it is mostly mainstream economic research that drives our knowledge on innovation and inequality, this review shows that, from a cross-disciplinary standpoint, this view is misleading. While economic studies do, indeed, dominate our knowledge on causal scenario I, development studies and employment relations studies lead our knowledge on causal scenarios 0, II and IV (see Table 6). Similarly, there appears to be a clear disciplinary perspective on explanatory factors (see Table 7). Mainstream economic research attributes causality to market-related factors (e.g., skill premiums, trade and technological unemployment). In contrast, research in other fields, including heterodox economic research, is more likely to examine – in addition to skill premiums – a host of other non-market factors (e.g., deunionization, types of innovation, innovation diffusion process, changing employment conditions, organizational factors, spatial aspects, digital gaps and sectoral change). While this finding showcases distinct specialization of knowledge among different fields,

Table 5. Causal scenarios

	All years	Early phase	Growth phase	Expansion phase	
Causal scenarios	**1990-2019**	**1990-1999**	**2000-2009**	**2010-2019**	**Trend directions**
	n=166	n=12	n=56	n=94	
0 – absence of causality	7.8	25.0	9.1	9.4	Decreasing, then slightly increasing
I – innovation induces inequality	71.1	58.3	70.9	73.1	Increasing
II – inequality stimulates innovation	6.0	8.3	7.3	7.5	Decreasing, then slightly increasing
III – innovation ameliorates inequality	6.0	8.3	5.5	5.6	Decreasing, then slightly increasing
IV – inequality hampers innovation	8.4	0.0	7.3	7.5	Increasing

Source: own elaboration

Table 6. Causal scenarios, fields and journals

Causal scenario	**Active fields**	**Most chosen journals (alphabetical order)**
0 – absence of causality	Employment relations, development studies, economics, other social sciences	*Agricultural Economics, Applied Economics, Canadian Public Policy, China Economic Review, Industrial and Labor Relations Review, Industrial Relations, Journal of Development Economics, Journal of International Studies, Labour, Work and Occupations, World Development*
I – innovation induces inequality	Economics, geography, employment relations, innovation studies, sociology	*American Economic Journal: Macroeconomics, American Sociological Review, Applied Economics, Applied Economics Letters, Economic Journal, Economics of Transition, Industrial and Corporate Change, International Review of Applied Economics, Journal of Development Economics, Journal of Economic Issues, Journal of the European Economic Association, Journal of International Economics, Quarterly Journal of Economics, Regional Studies, Review of Development Economics, Review of Economics and Statistics, Quarterly Journal of Economics, Social Indicators Research, Technological Forecasting and Social Change, World Development*
II – inequality stimulates innovation	Development studies, geography	*International Regional Science Review, Professional Geographer, World Development*
III – innovation ameliorates inequality	Economics, innovation studies	*Agricultural Economics, Asian Economic Journal, Eastern European Economics, Journal of the Knowledge Economy, Metroeconomica, Southeast Asian Journal of Economics, Technovation*
IV – inequality hampers innovation	Development studies, economics, geography	*Australian Geographer, Ecological Economics, Economic Development Quarterly, Environment and Development Economics, Gender, Technology and Development, GeoJournal, Information Economics and Policy, Scottish Journal of Political Economy, Work and Occupations, World Development*

Source: own elaboration

Table 7. Explanatory factors by field

Fields (alphabetical order)		Recurrent explanatory factors
Development studies		Skill premiums and trade (e.g., Esquivel and Rodrıguez-Lopez, 2003; Attanasio *et al.*, 2004; Meschi and Vivarelli, 2009), horizontal inequality (e.g., Mukhopadhyay and Nandi, 2007; Juhn *et al.*, 2014), policy (e.g., Rijkers *et al.*, 2010; Martorano and Sanfilippo, 2015),
Employment relations		Skill premiums (e.g., Brown and Campbell, 2001; Bruinshoofd *et al.,* 2001; Kim and Sakamoto, 2008; Stockhammer, 2017), deunionization (Belman and Levine, 2004; Black *et al.*, 2004), changing employment conditions (e.g., Colclough and Tolbert, 1990; Black *et al.*, 2004; Handel and Gittleman, 2004), horizontal inequality (e.g., Colclough and Tolbert, 1990; Asplund and Lilja, 2014)
Economics	Mainstream economics	Skill premiums (Krueger, 1993; Krusell *et al*., 2000), international trade (e.g., Bernard and Jensen, 1997; Baldwin and Cain, 2000; Adams, 2008), technological unemployment (e.g., Autor *et al*., 2003; Goos *et al*., 2014; Adermon and Gustavsson, 2015), innovation diffusion (e.g., Borghans and Ter Weel, 2007; Comin and Mestieri, 2018)
	Heterodox economics	Skill premiums (e.g., Manso, 2006), types of innovation (e.g., Bogliacino, 2009), innovation diffusion (e.g., Santos *et al.,* 2017), deunionization (e.g., MacPhail, 2000), national institutional framework (Richmond and Triplett, 2018), sectoral composition (e.g., Angelini *et al*., 2009)
Geography		Spatial aspects (e.g., Echeverri-Carroll and Ayala, 2009; Lee, 2011; Guo, 2019), digital gaps (e.g., Gibson, 2003; Otioma *et al.*, 2019), skill premiums (Wheeler, 2005; Consoli *et al*., 2013; Florida and Mellander, 2016), horizontal inequality (e.g., Pastor and Marcelli, 2000)
Innovation studies		Skill premiums (e.g., Chennells and Reenen, 1998; Martorano and Sanfilippo, 2015), diffusion (Brouwer and Brito, 2012; Thakur, 2012), technological unemployment (e.g., Mehic, 2018; Frey and Osborne, 2017)
Sociology		Horizontal inequality (McCall, 2000; Brynin and Perales, 2016; Cheng *et al*., 2019), deunionization (e.g., Kristal, 2013; Kristal and Cohen, 2017) and digital gaps (e.g., Martin and Robinson, 2007)

Source: own elaboration

Table 8. Causal scenarios and country

Causal Scenario	Most chosen research context
0 – absence of causality	US, cross-country analysis, China, Europe, Italy, Mexico, Philippines, Spain, Peru
I – innovation induces inequality	US, UK, Canada, cross-country analysis
II – inequality stimulates innovation	Cross-country analysis, US
III – innovation ameliorates inequality	Cross-country analysis, Brazil, China, Ethiopia, European Union, Peru, Thailand, Taiwan, UK
IV – inequality hampers innovation	US, Brazil, Mexico, Germany, India, South Korea

Source: own elaboration

it also challenges the explanatory ability of disciplinary research on innovation and inequality; in addition, it paves little ground for a cross-disciplinary research agenda.

Finally, a significant proportion of our knowledge of the relationship between innovation and inequality, especially causal scenario I (innovation induces inequality), has been based on

research in three English-speaking countries – the US, the UK and Canada. This is a significant issue that seems to affect the research outcome. As is shown in Table 8, studies focusing on non-liberal market economies (e.g., coordinated and state-led market economies) are less likely to report that innovation exacerbates inequality. In short, there appear to be some significant (external validity) questions that most studies under review have either, purposely or not, neglected or downgraded.

Knowledge gaps and critical remarks

The review process has detected several essential knowledge gaps that research could address in the years to come (for an overview, see Table 9). Specifically, in all causal scenarios, our knowledge on causal mechanisms is significantly wanting – causal mechanisms remain essentially black boxes that future research needs to unpack. This critical knowledge omission stems from an implicit methodological consensus in the literature that quantification and statistical significance are integral to a sophisticated analysis of causality, despite the fact that how innovation causes inequality 'has nothing to do with the number of times we have observed it happening' (Sayer, 2000b, p.14). This, among other issues, implies that observing a statistical net effect masks a multi-causal reality wherein reinforcing and antagonistic mechanisms shape the relationship between innovation and inequality. Putting it differently, strong, weak or absent statistical associations are, on their own, an unreliable indication of operative causal mechanisms.

Time is also important, namely to what extent are causal mechanisms ephemeral or enduring? Even though this study observed no significant difference in terms of findings among the different types of studies (short-, medium- and long-term), future research needs to make use of intensive research designs and methods (e.g., case study research, grounded theory and ethnography) as a means by which to extend and deepen our knowledge of the enduring nature of causality in general and causal mechanisms in particular (Archer, 2015; Fragkandreas, 2021). The views and experiences of, among others, employees, managers, and policymakers, including marginalized social actors, need to be integral to explanatory causal analysis of innovation and inequality. Otherwise, and because of its excessive, yet naive reliance on secondary statistics, the extant research could be criticized for being externalist (i.e., deliberately detached from the everyday world) and elitist (i.e., based exclusively on the views of researchers rather than the views of social actors).

In addition, research appears to have been neglectful of several key stylized facts regarding our knowledge of innovation (Fagerberg *et al.*, 2012; Martin, 2012). While several decades of innovation research have shown that innovation is a collective activity, often encompassing intense collaboration among a wide array of private and public actors (e.g., firms, suppliers, universities, governmental organizations, laboratories, banks, venture capitalists etc.) (Edquist, 2005; Lundvall, 2013), none of the studies under review have, to date, examined how collectivities of innovative actors (e.g., clusters, networks of innovation and innovation systems) shape the distribution of income. This is a significant knowledge gap as the skill premiums mechanism may, after all, be the result of network fragmentation (e.g., absent or weak university–industry interactions) among focal (triple helix) actors in innovation systems rather than simply the outcome of the supply and demand forces in labour markets (see, for instance, Christopherson and Clark, 2007; Lawton-Smith, 2009; Fragkandreas, 2021).

Furthermore, the great majority of studies under review seem to suffer from 'linear techno-fetishism' in the sense that innovation is conceptualized and analysed mainly as being a technological, linear, R&D-driven process. Future research needs to go beyond the narrow technological variables of innovation to examine the impact that different types of innovation (e.g., business model, product, incremental, organizational and institutional innovation) have on the distribution of income; for instance, by utilizing data from innovation surveys (Smith, 2005; Hong *et al.*, 2012) and alternative methodological approaches to extensive research (e.g., qualitative comparative analysis) to identify

configurations of factors (see, for instance, Greckhamer *et al.*, 2018). This could extend our knowledge not only on the composition of causal mechanisms, but also on the impact that different types of innovation have on the distribution of income, including the reverse (Veblenian) case in which existing inequalities, especially wealth inequality, shape the nature, direction and success of innovation (Cozzens and Kaplinsky, 2009; Piketty, 2014; Rikap and Lundvall, 2021).

In addition, extremely little is known about the distribution of economic rewards among innovative actors (e.g., global innovation networks, value chains and production networks) (Cozzens and Kaplinsky, 2009; Rikap and Lundvall, 2021). Future research needs to examine systematically wage inequality within (and between large and small) innovative firms. For instance, are large firms more unequal than small firms (Cirillo *et al*., 2017; Song *et al.*, 2019)? Emphasis must also be placed on the (ontological) fact that the income that innovation generates is, primarily, distributed within the legal boundaries of the firm (rather than in labour markets as the bulk of the extant economic literature implies) (Lazonick and Mazzucato, 2013; Tomaskovic-Devey and Avent-Holt, 2019; Rikap and Lundvall, 2021). Research on this issue could also help us to understand better the significantly overlooked relationship between innovation and top income inequality (Lazonick and Mazzucato, 2013; Aghion *et al.*, 2019), particularly how a set of high-income organizational actors (e.g., top executives) manage to convince other organizational actors (e.g., employees, labour union representatives and shareholders) that they deserve a significant share of the value that innovation generates (Kay and Hildyard, 2021; Rikap and Lundvall, 2021), even though, as Lazonick and Mazzucato (2013) emphasize, high-income organizational actors, including larger firms (e.g., high-technology giants), do not necessarily bear the lion's share of the risks involved in the innovation process (Rikap and Lundvall, 2021). This issue brings to the fore a largely under-researched aspect in the relationship between innovation and inequality, namely the nexus between innovation and wealth inequality: how does innovation affect wealth inequality and vice versa? Relatedly, more research needs to be dedicated to the distributional impact of innovation policies (Cozzens *et al.*, 2002; Zehavi and Breznitz, 2017; Schot and Steinmueller, 2018). In particular, how, and under what conditions, do innovation policies reduce or increase income differentials? This is an essential question with far-reaching implications for both theory and policy.

Policy implications

Despite being a critical stocktaking exercise, the present paper has a few policy implications and recommendations. The analysis in this paper confirms, among other issues, that contemporary innovation scholars and policymakers are right (albeit belatedly) to question the trickle-down thesis whereby innovation-driven growth will over time benefit less affluent individuals and social groups (e.g., OECD, 2011, 2015; Perez, 2013; Soete, 2013; Breznitz, 2021). Instead, at least as far as the experience in liberal market economies is concerned, the pressing question is that of 'innovation for inclusive growth' (e.g., Martin, 2016; Schot and Steinmueller, 2018; Lee, 2019: What kinds of innovation policies need to be in place to ensure that innovation-driven growth is much more inclusive than hitherto? Unfortunately, in this essential question, the existing research on innovation and inequality remains emphatically mute. Other than the main policy implications derived from the SBTC account – i.e., addressing skilled labour shortages could reduce skill premiums and incentivize firms, marginalized and low-skilled employees to invest in education and training (Acemoglu, 2002; Goos, 2018) – the existing research on innovation and inequality appears to be largely policy-irrelevant, despite one third of published research being sponsored by scientific and policymaking organizations. Policymakers (and research donors in general) need to stimulate policy-relevant research on innovation and inequality; for instance, by sponsoring research projects in which the underlying emphasis is on a cross-disciplinary, yet methodologically diverse, analysis geared towards unearthing active causal mechanisms (rather than registering a few statistically significant associations among variables). Funding various forms of interdisciplinary yet methodologically diverse research on innovation and inequality seems to be in the interest of knowledge creation, inclusive policy design and social cohesion.

Table 9. Causal scenarios and knowledge gaps

Causal Scenarios	Knowledge gaps and research questions
0 – absence of causality	• (How) Do skills, institutional factors, organizational strategies and types of innovation combine to form blocking mechanisms of inequality (i.e., mechanisms that countervail the inequality-inducing abilities of innovation)?
I – innovation induces inequality	• What are the mechanisms through which innovation induces top income, including wealth, inequality (Lazonick and Mazzucato, 2013; Aghion *et al.*, 2019)? • What strategies do innovative firms adopt to address skill shortages in the innovation process? And how do these strategies impact the (horizontal) distribution of income in innovative firms? • Are large innovative firms more unequal than small firms (Cirillo *et al.,* 2017)? • How does the collective nature of innovation (e.g., innovation ecosystems and (global) innovation networks) affect the distribution of income (Gray *et al.,* 1998; Fragkandreas, 2021)? • Under what conditions does innovation policy exacerbate inequality (Cozzens *et al.*, 2002)? • (How) Does the sectoral mode of innovation (e.g., science-based sectors, scale-intensive sectors etc.) affect the distribution of risks and rewards in the innovation process (Pavitt, 1984; Lazonick and Mazzucato, 2013)? • Does innovation embed an unequal distribution of risks and rewards (Lazonick and Mazzucato, 2013)? • Which (organizational) actor(s) take(s) the lion's share of risks in the innovation process? And who does capture the rewards? • Are some types of innovation (e.g., product innovation) more inequality-prone than others (e.g., process innovation and organizational innovation) (Angelini *et al.*, 2009; Bogliacino, 2009)? • How do a host of innovation-related factors combine to form causal mechanisms of inequality?
Causal scenario II – inequality stimulates innovation	• (How) Does inequality benefit the nature, direction and success of innovative activity (Yanadori and Cui, 2013)? • In what ways does inequality motivate (marginalized) actors to innovate or participate in the innovation process (Xavier-Oliveira *et al*., 2015)?
III – innovation ameliorates inequality	• How does innovation enable equality, inclusive competence building and social mobility (Lundvall, 2002; Xavier-Oliveira *et al.*, 2015)? • Do (inclusive) innovation policies ameliorate inequality (Zehavi and Breznitz, 2017; Schot and Steinmueller, 2018)?
IV – inequality hampers innovation	• How does rising inequality, including wealth concentration, shape the nature, direction, success and failure of innovative activity (Yanadori and Cui, 2013; Jung et al., 2018; Nakara *et al*., 2019) ?

Source: own elaboration

Limitations

As is the case with every study, this review could not escape the rule of limitations. By using the scholarly database with the most entries (Scopus), the analysis may have, unintentionally, overlooked a few studies which are not included in this database. Similarly, because of its epistemological aims, methodological criteria and the sheer number of papers under review (166), the paper did not consider conceptual and grey literature (e.g., books, book chapters and policy reports). In addition, the review process made no extensive use of advanced bibliometric methods. This was because a bibliographical coupling and co-citation analysis, which was conducted in the early phases of the review process (albeit not reported in this paper), added very little that was new to the analysis. In fact, it illustrated that, if uncritically applied, an ostensibly neutral method exhibits a systematic bias towards 'the skewed few' (Macdonald and Kam, 2011), namely mainstream economic research on innovation and inequality. Despite this, future reviews could make use of bibliometric tools as one

of the means by which to assess the extent to which a narrow mono-disciplinary perspective prevails in the more recent (i.e., post-2020) research. This type of analysis can be performed on policy papers and reports. This could help us determine whether policy documents favour certain disciplinary discourses and research streams. These are a few questions that future reviews on innovation and inequality may consider, among several other issues.

Appendix

Studies on innovation and inequality

Author	Year	Title	Journal
Adams, S.	2008	Globalization and income inequality: implications for intellectual property rights	*Journal of Policy Modeling*
Adermon, A., Gustavsson, M.	2015	Job polarization and task-biased technological change: evidence from Sweden, 1975–2005	*Scandinavian Journal of Economics*
Adrián Risso, W., Sánchez Carrera, E.	2019	On the impact of innovation and inequality in economic growth	*Economics of Innovation and New Technology*
Aghion, P., Akcigit, U., Bergeaud, A., Blundell, R., Hemous, D.	2019	Innovation and top income inequality	*Review of Economic Studies*
Alene, A., Coulibaly, O.	2009	The impact of agricultural research on productivity and poverty in sub-Saharan Africa	*Food Policy*
Almeida, A., Afonso, O.	2010	SBTC versus trade: testing skill-premia evidence across 25 OECD countries	*Applied Economics Letters*
Álvarez, R., López, R.	2009	Skill upgrading and the real exchange rate	*World Economy*
Angelini, E., Farina, F., Pianta, M.	2009	Innovation and wage polarisation in Europe	*International Review of Applied Economics*
Antonczyk, D., Deleire, T., Fitzenberger, B.	2018	Polarization and rising wage inequality: comparing the U.S. and Germany	*Econometrics*
Antonelli, C., Gehringer, A.	2017	Technological change, rent and income inequalities: a Schumpeterian approach	*Technological Forecasting and Social Change*
Antonelli, C., Scellato, G.	2019	Wage inequality and directed technological change: implications for income distribution	*Technological Forecasting and Social Change*
Arendt, Ł., Grabowski, W.	2019	Technical change and wage premium shifts among task-content groups in Poland	*Economic Research-Ekonomska Istrazivanja*
Arndt, C., Benfica, R., Tarp, F., Thurlow J., Uaiene R.	2010	Biofuels, poverty, and growth: a computable general equilibrium analysis of Mozambique	*Environment and Development Economics*
Asplund, R., Lilja, R.	2014	Wage formation and gender wage gaps: is there a role for job-task evaluation schemes?	*International Journal of Manpower*
Attanasio, O., Goldberg, P., Pavcnik, N.	2004	Trade reforms and wage inequality in Colombia	*Journal of Development Economics*
Autor, D., Katz, L., Kearney, M.	2008	Trends in U.S. wage inequality: revising the revisionists	*Review of Economics and Statistics*
Baldwin, R., Cain, G.	2000	Shifts in relative U.S. wages: the role of trade, technology, and factor endowments	*Review of Economics and Statistics*
Barua, A., Ghosh, P.	2017	Factor specificity and wage inequality in a developing economy: the role of technology and trade in Indian manufacturing	*International Review of Economics and Finance*
Belman, D., Levine, D.	2004	Size, skill and sorting	*Labour*
Belman, D., Monaco, K.	2001	The effects of deregulation, de-unionization, technology, and human capital on the work and work lives of truck drivers	*Industrial and Labor Relations Review*

Author	Year	Title	Journal
Bernard, A., Jensen, J.	1997	Exporters, skill upgrading, and the wage gap	*Journal of International Economics*
Black, S., Lynch, L., Krivelyova A.	2004	How workers fare when employers innovate	*Industrial Relations*
Blum, B.	2008	Trade, technology, and the rise of the service sector: the effects on US wage inequality	*Journal of International Economics*
Bogliacino, F.	2009	Poorer workers: the determinants of wage formation in Europe	*International Review of Applied Economics*
Bonjean, I.	2019	Heterogeneous incentives for innovation adoption: the price effect on segmented markets	*Food Policy*
Borghans, L., ter Weel, B.	2007	The diffusion of computers and the distribution of wages	*European Economic Review*
Breau, S., Kogler, D., Bolton, K.	2014	On the relationship between innovation and wage inequality: new evidence from Canadian cities	*Economic Geography*
Bresnahan, T.	1999	Computerisation and wage dispersion: an analytical reinterpretation	*Economic Journal*
Broccolini, C., Turco, A., Presbitero, A., Staffolani, S.	2011	Individual earnings, international outsourcing and technological change: evidence from Italy	*International Economic Journal*
Brouwer, R., Brito, L.	2012	Cellular phones in Mozambique: who has them and who doesn't?	*Technological Forecasting and Social Change*
Brown, C., Campbell, B.	2001	Technical change, wages, and employment in semiconductor manufacturing	*Industrial and Labor Relations Review*
Bruinshoofd, A., Hollanders, H., Ter Weel, B.	2001	Knowledge spillovers and wage inequality: an empirical analysis of Dutch manufacturing	*Labour*
Brynin, M., Perales, F.	2016	Gender wage inequality: the de-gendering of the occupational structure	*European Sociological Review*
Chakraborty, J., Bosman, M.	2005	Measuring the digital divide in the United States: race, income, and personal computer ownership	*Professional Geographer*
Chang, Y., Cho, S., Kim, I., Khang, Y.-H.	2019	Socioeconomic inequalities in e-cigarette use in Korea: comparison with inequalities in conventional cigarette use using two national surveys	*International Journal of Environmental Research and Public Health*
Cheng, S., Chauhan, B., Chintala, S.	2019	The rise of programming and the stalled gender revolution	*Sociological Science*
Chennells, L., Reenen, J.V.	1998	Establishment level earnings, technology and the growth of inequality: evidence from Britain	*Economics of Innovation and New Technology*
Choi, K.-S., Jeong, J.	2005	Technological change and wage premium in a small open economy: the case of Korea	*Applied Economics*
Cirillo, V., Sostero, M., Tamagni, F.	2017	Innovation and within-firm wage inequalities: empirical evidence from major European countries	*Industry and Innovation*
Colclough, G., Tolbert, C.	1990	High technology, work, and inequality in southern labor markets	*Work and Occupations*
Colclough, G., Tolbert, C.	2001	Transformations of hightech labor markets and socioeconomic inequalities	*Sociological Focus*
Comin, D., Mestieri, M.	2018	If technology has arrived everywhere, why has income diverged?	*American Economic Journal: Macroeconomics*
Commander, S., Kollo, J.	2008	The changing demand for skills: evidence from the transition	*Economics of Transition*
Consoli, D., Vona, F., Saarivirta, T.	2013	Analysis of the graduate labour market in Finland: spatial agglomeration and skill-job match	*Regional Studies*

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Author	Year	Title	Journal
Cook, P., Uchida, Y.	2008	Structural change, competition and income distribution	*Quarterly Review of Economics and Finance*
Cozzens, S., Bobb, K.	2003	Measuring the relationship between high technology development strategies and wage inequality	*Scientometrics*
Cozzens, S., Bobb, K., Deas, K., Gatchair, S., George, A., Ordonez, G.	2005	Distributional effects of science and technology-based economic development strategies at state level in the United States	*Science and Public Policy*
Cozzi, G., Impullitti, G.	2010	Government spending composition, technical change, and wage inequality	*Journal of the European Economic Association*
Croce, G., Ghignoni, E.	2020	The evolution of wage gaps between STEM and non-STEM graduates in a technological following economy	*Applied Economics*
Dell'Anno, R., Solomon, H.	2014	Informality, inequality, and ICT in transition economies	*Eastern European Economics*
Ding, S., Meriluoto, L., Reed, W., Tao, D., Wu, H.	2011	The impact of agricultural technology adoption on income inequality in rural China: evidence from southern Yunnan Province	*China Economic Review*
Doussard, M., Peck, J., Theodore, N.	2009	After deindustrialization: uneven growth and economic inequality in 'postindustrial' Chicago	*Economic Geography*
Dueñas-Fernández, D., Iglesias-Fernández, C., Llorente-Heras, R.	2015	Is there less gender inequality in the service sector? The gender wage-gap in knowledge-intensive services	*Social Science Information*
Dustmann, C., Ludsteck, J., Schönberg, U.	2009	Revisiting the German wage structure	*Quarterly Journal of Economics*
Echeverri-Carroll, E., Ayala, S.	2009	Wage differentials and the spatial concentration of high-technology industries	*Papers in Regional Science*
Echeverri-Carroll, E., Oden, M., Gibson, D., Johnston, E.	2018	Unintended consequences on gender diversity of high-tech growth and labor market polarization	*Research Policy*
Engelmann, S.	2014	International trade, technological change and wage inequality in the UK economy	*Empirica*
Englehardt, S.	2009	The evolution of skill-biased effects on American wages in the 1980s and 1990s	*Journal of Labor Research*
Eriksson, T., Pytliková, M., Warzynski F.	2013	Increased sorting and wage inequality in the Czech Republic: new evidence using linked employer-employee dataset	*Economics of Transition*
Esquivel, G., Rodríguez-López, J.	2003	Technology, trade, and wage inequality in Mexico before and after NAFTA	*Journal of Development Economics*
Faggio, G., Salvanes, K., van Reenen, J.	2010	The evolution of inequality in productivity and wages: panel data evidence	*Industrial and Corporate Change*
Falkinger, J., Zweimüller, J.	1997	The impact of income inequality on product diversity and economic growth	*Metroeconomica*
Fernandez, R.	2001	Skill-biased technological change and wage inequality: evidence from a plant retooling	*American Journal of Sociology*
Florida, R., Mellander, C.	2016	The geography of inequality: difference and determinants of wage and income inequality across US metros	*Regional Studies*
Freebairn, D.	1995	Did the green revolution concentrate incomes? A quantitative study of research reports	*World Development*

Author	Year	Title	Journal
Frey, C., Osborne, M.	2017	The future of employment: how susceptible are jobs to computerisation?	*Technological Forecasting and Social Change*
Fuchs, C.	2009	The role of income inequality in a multivariate cross-national analysis of the digital divide	*Social Science Computer Review*
Gaggl, P., Wright, G.	2017	A short-run view of what computers do: evidence from a UK tax incentive	*American Economic Journal: Applied Economics*
Ge, S., Yang, D.	2014	Changes in China's wage structure	*Journal of the European Economic Association*
Gibson, C.	2003	Digital divides in New South Wales: a research note on socio-spatial inequality using 2001 census data on computer and internet technology	*Australian Geographer*
Goel, M.	2017	Inequality between and within skill groups: the curious case of India	*World Development*
Gray, M., Golob, E., Markusen, A., Park, S.	1998	New industrial cities? The four faces of Silicon Valley	*Review of Radical Political Economics*
Greenwood, J., Guner, N., Kocharkov, G., Santos, C.	2016	Technology and the changing family: a unified model of marriage, divorce, educational attainment, and married female labor-force participation	*American Economic Journal: Macroeconomics*
Guo, Q.	2019	Analysis on the relationship between regional innovation and income inequality in Chinese city regions	*Professional Geographer*
Hagos, F., Jayasinghe, G., Awulachew, S., Loulseged, M., Yilma, A.	2012	Agricultural water management and poverty in Ethiopia	*Agricultural Economics (United Kingdom)*
Hall, J.	2019	Measuring the diffusion of technologies through international trade	*International Advances in Economic Research*
Handel, M., Gittleman, M.	2004	Is there a wage payoff to innovative work practices?	*Industrial Relations*
Hanley, C.	2014	Putting the bias in skill-biased technological change? A relational perspective on white-collar automation at General Electric	*American Behavioral Scientist*
Haskel, J., Slaughter, M.	2001	Trade, technology and U.K. wage inequality	*Economic Journal*
Hatipoglu, O.	2012	The relationship between inequality and innovative activity: a Schumpeterian theory and evidence from cross-country data	*Scottish Journal of Political Economy*
Hilbert, M.	2010	When is cheap, cheap enough to bridge the digital divide? Modeling income related structural challenges of technology diffusion in Latin America	*World Development*
Hope, D., Martelli, A.	2019	The transition to the knowledge economy, labor market institutions, and income inequality in advanced democracies	*World Politics*
Hühne, P., Herzer, D.	2017	Is inequality an inevitable by-product of skill-biased technical change?	*Applied Economics Letters*
Hyytinen, A., Toivanen, O.	2011	Income inequality and technology diffusion: evidence from developing countries	*Scandinavian Journal of Economics*
James, J., Khan, H.	1997	Technology choice and income distribution	*World Development*
Jaumotte, F., Lall, S., Papageorgiou, C.	2013	Rising income inequality: technology, or trade and financial globalization?	*IMF Economic Review*
Jerzmanowski, M., Nabar, M.	2013	Financial development and wage inequality: theory and evidence	*Economic Inquiry*

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Juhn, C., Ujhelyi, G., Villegas-Sanchez, C.	2014	Men, women, and machines: how trade impacts gender inequality	*Journal of Development Economics*
Jung, H., Seo, I., Jung, K.	2018	Mediating role of entrepreneurship in explaining the association between income inequality and regional economic performance	*Economic Development Quarterly*
Katz, V., Gonzalez, C., Clark, K.	2017	Digital inequality and developmental trajectories of low-income, immigrant, and minority children	*Pediatrics*
Kawaguchi, D., Mori, Y.	2016	Why has wage inequality evolved so differently between Japan and the US? The role of the supply of college-educated workers	*Economics of Education Review*
Kharlamova, G., Stavytskyy, A., Zarotiadis, G.	2018	The impact of technological changes on income inequality: the EU states case study	*Journal of International Studies*
Kijima, Y.	2006	Why did wage inequality increase? Evidence from urban India 1983–99	*Journal of Development Economics*
Kim, C., Sakamoto, A.	2008	Does inequality increase productivity? Evidence from U.S. manufacturing industries, 1979 to 1996	*Work and Occupations*
Kristal, T.	2013	The capitalist machine: computerization, workers' power, and the decline in labor's share within U.S. industries	*American Sociological Review*
Kristal, T., Cohen, Y.	2017	The causes of rising wage inequality: the race between institutions and technology	*Socio-Economic Review*
Krueger, A.	1993	How computers have changed the wage structure: evidence from microdata, 1984–1989	*Quarterly Journal of Economics*
Krusell, P., Ohanian, L., Ríos-Rull, J., Violante, G.	2000	Capital-skill complementarity and inequality: a macroeconomic analysis	*Econometrica*
Langer, L.	2001	The consequences of state economic development strategies on income distribution in the American states, 1976 to 1994	*American Politics Research*
Lee, J., Wie, D.	2015	Technological change, skill demand, and wage inequality: evidence from Indonesia	*World Development*
Lee, N.	2011	Are innovative regions more unequal? Evidence from Europe	*Environment and Planning C: Government and Policy*
Lee, N., Rodríguez-Pose, A.	2013	Innovation and spatial inequality in Europe and USA	*Journal of Economic Geography*
Lee, S.	2017	International trade and within-sector wage inequality: the case of South Korea	*Journal of Asian Economics*
Lemieux, T.	2006	Increasing residual wage inequality: composition effects, noisy data, or rising demand for skill?	*American Economic Review*
Lin, K., Tomaskovic-Devey, D.	2013	Financialization and U.S. income inequality	*American Journal of Sociology*
Lindley, J., Machin, S.	2014	Spatial changes in labour market inequality	*Journal of Urban Economics*
Machin, S.	1998	Recent shifts in wage inequality and the wage returns to education in Britain	*National Institute Economic Review*
MacPhail, F.	2000	What caused earnings inequality to increase in Canada during the 1980s?	*Cambridge Journal of Economics*
Manso, E.	2006	The influence of earnings on income distribution in the United States	*Journal of Socio-Economics*
Martin, S., Robinson, J.	2007	The income digital divide: trends and predictions for levels of internet use	*Social Problems*

Author	Year	Title	Journal
Martínez, M., Fuensanta, M., Rodríguez, I.	2013	The influence of socioeconomic factors on entrepreneurship and innovation	*Journal of Small Business Strategy*
Martorano, B., Park, D., Sanfilippo, M.	2017	Catching-up, structural transformation, and inequality: industry-level evidence from Asia	*Industrial and Corporate Change*
Martorano, B., Sanfilippo, M.	2015	Structural change and wage inequality in the manufacturing sector: long run evidence from East Asia	*Oxford Development Studies*
McCall, L.	2000	Explaining levels of within-group wage inequality in U.S. labor markets	*Demography*
McCall, L.	2000	Gender and the new inequality: explaining the college/non-college wage gap	*American Sociological Review*
Mehic, A.	2018	Industrial employment and income inequality: evidence from panel data	*Structural Change and Economic Dynamics*
Mendonça, S., Crespo, N., Simões, N.	2015	Inequality in the network society: an integrated approach to ICT access, basic skills, and complex capabilities	*Telecommunications Policy*
Meschi, E., Vivarelli, M.	2009	Trade and income inequality in developing countries	*World Development*
Mishel, L., Bernstein, J.	2003	Wage inequality and the new economy in the US: does IT-led growth generate wage inequality	*Canadian Public Policy*
Močnik, D., Širec, K.	2010	The determinants of internet use controlling for income level: cross-country empirical evidence	*Information Economics and Policy*
Moreno-Galbis, E., Wolff, F.	2011	Evidence on new technologies and wage inequality in France	*Applied Economics*
Mosher, J.	2007	U.S. wage inequality, technological change, and decline in union power	*Politics and Society*
Mukhopadhyay, S., Nandi, R.	2007	Unpacking the assumption of gender neutrality: Akshaya project of the Kerala IT mission in India	*Gender, Technology and Development*
Nakara, W., Messeghem, K., Ramaroson, A.	2019	Innovation and entrepreneurship in a context of poverty: a multilevel approach	*Small Business Economics*
Nogueira, M., Afonso, Ó.	2018	Intra-country wage inequality in the OECD countries	*Panoeconomicus*
Nogueira, M., Afonso, Ó., Soukiazis, E.	2018	Skill premium in Portuguese manufacturing industries	*Applied Economics Letters*
Ojala, J., Pehkonen, J., Eloranta, J.	2016	Deskilling and decline in skill premium during the age of sail: Swedish and Finnish seamen, 1751–1913	*Explorations in Economic History*
Otioma, C., Madureira, A., Martinez, J.	2019	Spatial analysis of urban digital divide in Kigali, Rwanda	*GeoJournal*
Otsuka, K., Cordova, V., David, C.	1990	Modern rice technology and regional wage differentials in the Philippines	*Agricultural Economics*
Pastor, M., Jr., Marcelli, E.	2000	Men n the hood: skill, spatial, and social mismatch among male workers in Los Angeles County	*Urban Geography*
Pehkonen, J., Neuvonen, T., Ojala, J.	2019	Technological change and wage premiums amongst high-skilled labour	*Applied Economics Letters*
Peng, F., Kang, L.	2013	Labor market institutions and skill premiums: an empirical analysis on the UK, 1972–2002	*Journal of Economic Issues*
Permana, M., Lantu, D., Suharto, Y.	2018	The effect of innovation and technological specialization on income inequality	*Problems and Perspectives in Management*

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Author	Year	Title	Journal
Perugini, C., Pompei, F.	2009	Technological change and income distribution in Europe	*International Labour Review*
Reshef, A.	2013	Is technological change biased towards the unskilled in services? An empirical investigation	*Review of Economic Dynamics*
Richmond, K., Triplett, R.	2018	ICT and income inequality: a cross-national perspective	*International Review of Applied Economics*
Rijkers, B., Ruggeri Laderchi, C., Teal, F.	2010	Who benefits from promoting small enterprises? Some empirical evidence from Ethiopia	*World Development*
Roser, M., Cuaresma, J.	2016	Why is income inequality increasing in the developed world?	*Review of Income and Wealth*
Saini, S., Mehra, M.	2018	Impact of strengthening intellectual property rights regime on income inequality: an econometric analysis	*Economics Bulletin*
Santos, M., Sequeira, T., Ferreira-Lopes, A.	2017	Income inequality and technological adoption	*Journal of Economic Issues*
Scott, P.	2011	Still a niche communications medium: the diffusion and uses of the telephone system in interwar Britain	*Business History*
Shahabadi, A., Nemati, M., Hosseinidoust, S.	2017	The effect of knowledge economy factors on income inequality in the selected Islamic countries	*Journal of the Knowledge Economy*
Stockhammer, E.	2017	Determinants of the wage share: a panel analysis of advanced and developing economies	*British Journal of Industrial Relations*
Subramanian, A., Qaim, M.	2009	Village-wide effects of agricultural biotechnology: the case of Bt Cotton in India	*World Development*
Suphanachart, W.	2019	Effects of technological change on income inequality in Thailand	*Southeast Asian Journal of Economics*
Tansel, A., Bodur, F.	2012	Wage inequality and returns to education in Turkey: a quantile regression analysis	*Review of Development Economics*
Taylor, K.	2006	UK wage inequality: an industry and regional perspective	*Labour*
Thakur, D.	2012	A limited revolution: the distributional consequences of open source software in North America	*Technological Forecasting and Social Change*
Thakur, D.	2012	Market competition and the distributional consequences of mobile phones in Canada	*Technological Forecasting and Social Change*
Thapa, G., Otsuka, K., Barker, R.	1992	Effect of modern rice varieties and irrigation on household income distribution in Nepalese villages	*Agricultural Economics*
Thewissen, S., van Vliet, O., Wang, C.	2018	Taking the sector seriously: data, developments, and drivers of intrasectoral earnings inequality	*Social Indicators Research*
Toh, R., Tat, H.	2012	Trade liberalization, labor demand shifts and earnings inequality in Singapore	*Review of Urban and Regional Development Studies*
Torres, N., Afonso, Ó., Soares, I.	2017	Manufacturing skill-biased wage inequality, natural resources and institutions	*Review of Development Economics*
Tselios, V.	2011	Is inequality good for innovation?	*International Regional Science Review*
Tsou, M.	2002	Wage differentials in Taiwanese manufacturing, 1982–1997	*Asian Economic Journal*
Tyrowicz, J., Smyk, M.	2019	Wage inequality and structural change	*Social Indicators Research*
Vona, F., Patriarca, F.	2011	Income inequality and the development of environmental technologies	*Ecological Economics*
Walton, M., Pallitt, N.	2012	'Grand Theft South Africa': Games, literacy and inequality in consumer childhoods	*Language and Education*

Author	Year	Title	Journal
Warman, C., Worswick, C.	2015	Technological change, occupational tasks and declining immigrant outcomes: implications for earnings and income inequality in Canada	*Canadian Journal of Economics*
Wei, Y., Liu, X., Song, H., Romilly, P.	2001	Endogenous innovation growth theory and regional income convergence in China	*Journal of International Development*
Weinhold, D., Nair-Reichert, U.	2009	Innovation, inequality and intellectual property rights	*World Development*
Wheeler, C.	2005	Cities, skills, and inequality	*Growth and Change*
Włodarczyk, J.	2017	Innovations and income inequalities: a comparative study	*Journal of International Studies*
Woodson, T., Alcantara, J., do Nascimento, M.	2019	Is 3D printing an inclusive innovation? An examination of 3D printing in Brazil	*Technovation*
Xu, B., Li, W.	2008	Trade, technology, and China's rising skill demand	*Economics of Transition*
Xu, Y., Ouyang, A.	2015	China wage inequality: the role of trade and technology	*Applied Economics*

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