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Functional Specialisation and Working Conditions in Europe

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This Working Paper at a Glance
Specialisation in value-chain functions is one of the new phenomena introduced by global value chains and holds great potential for productivity gains. The advantages of global value chain integration, however, could be potentially countered by unfavourable functional specialisation. This study shows that functional specialisation in production activities ('fabrication') tends to hold back wages. For Central and East European EU member states, a specialisation as 'factory economies' could thus become a development trap.

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Abstract

Specialisation in value-chain functions is one of the new phenomena introduced by global value chains (GVCs). This report investigates the effects of functional specialisation on labour markets in fabrication and research and development (R&D) activities as the two polar cases of value-chain functions, whereby the former is associated with factory economies, while the latter is characteristic of headquarter economies. More precisely, a metric similar to revealed comparative advantage is used to study the effect of relative functional specialisation on wages and non-wage working conditions.

In line with the GVC literature emphasising power relations and organisational aspects of production networks, we are able to identify differentiated effects for functional specialisation patterns on wages in EU member states at the industry level across time. While relative functional specialisation in fabrication tends to hold back wages, functional specialisation in R&D has a positive effect on wage progression, controlling for labour productivity, participation in global value chains and numerous labour supply- and labour demand-side factors.

The use of a constructed 'sharp' instrument allows giving these results a causal interpretation. Conversely, both functional specialisation measures are found to improve some non-wage working conditions, namely workers' physical environment and their work intensity, which is evidence against a potential 'race to the bottom' effect of functional specialisation along global value chains. The effect is stronger for relative specialisation in fabrication than for relative specialisation in R&D.

1. Introduction

With the rise of global value chains (GVCs)[1] as a defining element of production networks in the globalised world a new dimension of specialisation has emerged, namely the specialisation of economies along individual activities, or functions, of the value chain that have come to stand alongside specialisation in different products or industries (Timmer et al., 2019; Stöllinger, 2021).

The two forms of specialisation in GVCs play out in such a way that, for instance, an economy can be *sectorally* specialised in machinery and transport equipment, while at the same being time *functionally* specialised in research and development (R&D) activities as part of the production process.

By contrast, another economy could be equally specialised in machinery and transport equipment from an industry perspective but engage more heavily in fabrication and assembly, thereby taking on an entirely different functional role in the GVC. What is evident here is that the two dimensions of specialisation – industries and functions – are not in conflict with each other but rather provide supplementary information regarding the structural characteristics of an economy. The particularity of the functional specialisation dimension, which is more recent, is that it is inextricably linked to GVCs and reflects the associated, increasingly granular international division of labour.

Functional specialisation has long played a role in the theoretical analysis of GVCs (Gereffi et al., 2005; Kaplinsky, 2000; Kaplinsky, 2019; Milberg and Winkler, 2013). A prominent application area of the functional dimension of specialisation lies in the discussion of structural upgrading within the realm of GVCs. In this way, a case is put forward for the relevance of functional specialisation from a developmental perspective. As Humphrey and Schmitz (2002) point out, upgrading within GVCs can be done in a variety of ways: one way is through product upgrading, i.e. producing 'better' products in their quality and value, while another way can be linked to process upgrading, whereby an economy learns to produce the same goods more efficiently.

Alternatively, an economy can shift between products and participate in more sophisticated value chains, dubbed inter-industry upgrading. In addition to these three options, it is proposed that structural change can also take the form of functional upgrading, that is, an economy can

1 We use here the term global value chains as established in the literature, comprising both regional and 'truly' global value chains. This is worth mentioning, as international value chains are often regional in scope.

achieve structural upgrading by taking on functions that have a higher potential to capture value added within the same value chain.

As functional divisions are tightly linked to international trade and foreign direct investments (FDI), a stream of theoretical GVC literature originating from trade theory also sheds light on the relevance of specialisations based on functions (e.g. Feenstra and Hanson, 1996; Grossman and Rossi-Hansberg, 2008; Baldwin and Robert-Nicoud, 2014).[2] The focus here is on the concept of 'offshoring', which according to Feenstra (2008) has been sparked by relative wage developments that are difficult to explain using traditional trade models. In turn, the firm-level-oriented GVC literature typically analyses wages in the context of rent distribution and unequal exchange (Kaplinsky, 2000; Kaplinsky, 2019).

In this view, the position of countries along the value chain is a decisive factor for the part of the economic rents accruing to them. The claim here is that countries which perform simple production activities, such as final assembly, will earn lower rents (translating into low, stagnant wages), while the firms in control of the production networks and specialised in knowledge-intensive activities, such as R&D or management, will earn high rents. By and large, these firms tend to be located in high-income 'Western' countries (Wade, 2018) and can thus afford to pay higher wages. In this sense, a common denominator of the conceptual GVC literature discussed above is the focal interest in wages and rents associated with functional specialisations.

The prominence of functional upgrading in the theoretical GVC literature is in stark contrast to the scarcity of empirical analysis of the topic. The different types of GVC upgrading as defined in Humphrey and Schmitz (2002) have been analysed extensively in the empirical literature using different indicators. Typically, individual facets of GVC upgrading are analysed. For example, Kummritz (2016) and Pahl et al. (2022) analyse productivity, which relates to process upgrading, while Kaplinsky and Readman (2005) and Amighini (2006) essentially capture product upgrading by jointly tracking the evolution of industry-level export unit values and world export market share.

A more comprehensive approach is taken by Tian et al. (2021), who estimate the effects of GVC participation on product, process and skills upgrading using composite variables for all three dimensions retrieved in an earlier work from a factor analysis (Tian et al., 2019). They argue that functional upgrading can be proxied by skills upgrading. A deeper empirical examination of functional upgrading within GVCs remains relatively unexplored in the literature.

2 In this literature, the activities which we label functions are referred to as 'tasks'.

In this paper we attempt to fill this perceived gap, which concerns the implications of functional specialisation on social upgrading. To this end, industry-specific measures for functional specialisation – the one trade-based (Timmer et al., 2019), the other FDI-based (Stöllinger, 2021) – are used to estimate the effects on wages and other non-wage working conditions over a period of almost 20 years (2000–2019) for 25 EU member states.[3]

The fact that the analysis is performed at the industry level is not only advantageous from a methodological point of view but also echoes the point that the approaches to functional specialisation in Timmer et al. (2019) and Stöllinger (2021) treat the functional dimension separately from the industry dimension. Moreover, the trade-based and FDI-based measures are constructed using entirely independent datasets and following completely different methodologies, so that they complement each other and also allow for interesting comparisons.

One may see the combination of functional specialisation with working condition also in relation to the discussion of social upgrading as a supplement to the notion of industrial upgrading. The main concern in this strand of the literature is that there is no automatic link between economic upgrading in GVCs and the wider social conditions of employees. These conditions are referred to as social upgrading (Milberg and Winkler, 2013) and all point in one way or the other to labour market conditions (e.g. informal work, unpaid work, social insurance, etc.).

As with economic upgrading, numerous indicators have been proposed to measure this phenomenon, with the combination of wages and employment expansion (Amighini, 2006; Kaplinsky and Readman, 2005) being one of the most popular measures. However, other work-related aspects also deserve attention, including the general (physical or social) work environment, work intensity or worktime quality.

Furthermore, the rationale for focusing exclusively on the functional dimension of GVC upgrading and labour markets is rooted in the belief that functions are most closely related to GVCs and hence play a decisive role in the potential for capturing value added. In line with Baldwin (2013) and Baldwin and Lopez-Gonzalez (2015), this paper starts from the premise that the specialisation in different segments of the value chain reflects strong technological asymmetries between the firms and countries forming part of the same GVC.

This fragmentation of value-added creation processes across countries has given rise to countries specialising as 'headquarter economies'

3 This includes the United Kingdom, which was part of the EU throughout this period. Luxembourg, Malta and Cyprus are excluded due to data availability limitations.

and 'factory economies'.[4] Headquarter economies possess advanced technologies (e.g. the US, Japan and Germany), provide management skills and technologies and perform R&D within the production network, while low-wage countries (factory economies) provide predominantly unskilled labour and occupy the fabrication segment of the value chain.[5] Functional specialisations of this kind will certainly follow existing comparative advantages.

However, we shall also argue that there are reasons to believe that different functional specialisations have different implications for capturing rents, and hence for wage developments. In this respect, this paper relates not only to the social upgrading literature but also to the concept of the smile curve (Shih, 1996; Shin et al., 2012).

The key proposition here is that various segments of a value chain are associated with varying potential for capturing value added, with the fabrication stage – occupied by factory economies – being the least favourable segment. Such a 'feed-back' effect running from functional specialisation to wages is arguably related to the phenomenon of the middle-income trap (Gill and Kharas, 2007), and in turn, one could speak of a 'functional trap' associated with certain functional specialisation patterns (Stöllinger, 2019).[6]

To guide the econometric specification of our analysis, we follow the part of the labour literature which tries not only to explain wages with supply-side factors such as labour productivity and human capital but also to account for (macroeconomic) demand-side and structural factors (McCausland et al., 2020). For the analysis of non-wage working conditions, such as the physical or social environment, work intensity, work-time quality or prospects, to name but a few, we use a similar economet-

4 Baldwin (2006) first used the concept of 'Factory Asia' to describe the observed trend in Asian production processes in which Japanese companies headquartered in Japan manufacture high-tech parts in Japan and ship them to factories in East Asian countries for labour-intensive production steps, including assembly, and then distribute the final products to Western markets or back to Japan. Other countries, such as Taiwan, Singapore and Hong Kong, followed the Japanese practice. Hence the latter group of countries were referred to as 'headquarter economies', while the low-wage East Asian countries were labelled 'factory economies'. This terminology is still used in the GVC literature.

5 In the context of value-chain functions we use the terms production and the less common term fabrication interchangeably. The reason is that when referring to production activities as one function of the value chain, the term 'fabrication function' avoids the ambiguity implied by the term 'production function', which has an entirely different meaning in economics.

6 The debate about an middle-income trap is not limited to middle-income countries as defined by the World Bank but extends to countries classified as high-income, such as Poland and other Central and East European countries (see for example Győrffy, 2022).

ric approach, albeit with some variations to allow for the structure of the available data.

The remainder of this paper is structured as follows. Section 2 provides the theoretical background for the analysis and derives the hypotheses to be tested in the empirical model. This model, including the instrumental variable strategy, is explained in Section 3, along with the indicators for measuring functional specialisation and the data sources. Section 4 presents and discusses the results and Section 5 contains the conclusions.

2. Theoretical background and hypotheses

The functional dimension of the international division of labour adds an additional layer of specialisation within GVCs, separable from traditional specialisations in industries and products (Stöllinger, 2021). Against this background, the theoretical consideration about the relationship between functional specialisation of countries and their respective wages is the presumption that different functional specialisations are a reflection of cross-country technological asymmetries (Baldwin and Lopez-Gonzalez, 2015).

Countries which are well-endowed with skills and state-of-the art technologies will specialise in knowledge-intensive value-chain functions such as R&D or selected business services and maintain control over the overwhelming majority of international production networks (headquarter economies). Thus, borrowing the terminology from the literature on multinational enterprises (MNEs), these economies can be regarded as the 'systems integrators' of global production networks (Nolan et al., 2007). In contrast, countries which are relatively abundant in unskilled labour but (in most industries) remain behind the technological frontier will mainly provide labour inputs to GVCs (factory economies).

In this sense, the labour division patterns in GVCs reflect relative abundance and scarcity of technological and labour endowments, which is not far removed from the classical theories of internationalisation, such as the Heckscher-Ohlin theorem. Indeed, Kordalska et al. (2022) document the existence of two distinct 'functional clusters' in the EU that correspond to this headquarter economy-factory economy dichotomy. By and large the 'old' EU member states act as headquarter economies, while the Central and East European EU member states (EU-CEE) take on the role of factory economies.

Yet, the sheer existence of a functional dichotomy within the EU does not confirm the suspected implications of such patterns from an economic perspective. This is because measures of relative functional specialisation explored in Kordalska et al. (2022) do not in themselves carry information about performance. Rather, they hold information on comparative advantages of economies in different business functions as revealed in trade and FDI flows. Hence, without further investigation one can only hypothesise the economic implications associated with a headquarter-factory division of labour.

Therefore, taking the empirical analysis further, the focus of this study is on the consequences of functional specialisation for wages and other non-wage working conditions in the EU context. Observing a country's functional specialisation within industries and over time, it is possible to identify whether changes in the functional specialisation patterns are positively or negatively related to wage developments over time, again at the country-industry level. The econometric techniques employed allow for a causal interpretation of the results. In this way, the aim is to explore the implications of the functional facet of economic upgrading discussed in Humphrey and Schmitz (2002) on labour market outcomes.

As mentioned above, changes in social conditions are commonly referred to as social upgrading – or downgrading, as the case may be (Milberg and Winkler, 2013). Hence, by analysing the relationship between functional specialisation patterns on the one hand and wages and other non-wage working conditions on the other, we are also investigating the relationship between economic upgrading and social upgrading.

The empirical results regarding this relationship must be considered to be inconclusive, which is due to the numerous dimensions of economic upgrading, differences in measurement and indicators, different levels of analysis (firm level, industry level, macro level) as well as research methodology (case studies, comparative cross-country and cross-industry analysis). By focusing on functional specialisation as one of the – in our view – key dimensions of economic upgrading, we can hope to obtain more uniform results.

To sharpen the analysis, we focus on two of the value-chain functions analysed in Kordalska et al. (2022). More precisely, we restrict the analysis to the value-chain functions, R&D activities and fabrication, as two polar cases of functional specialisation. Investigating the specialisation patterns in fabrication and R&D can be seen as the 'functional equivalent' to the well-known differentiation between 'progressive' (high-productivity sectors) and 'traditional' sectors (sectors with stagnant productivity) in the structural change literature (going back to Baumol, 1967).

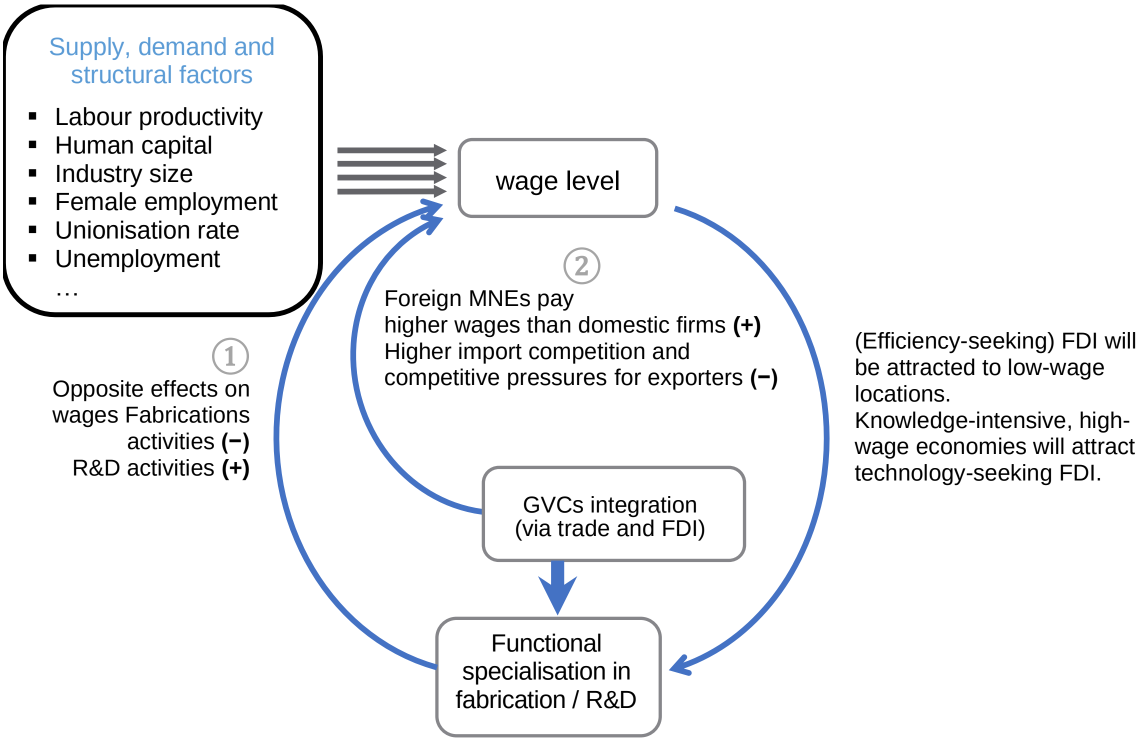
Obviously, the R&D function is representative of 'progressive' countries specialising as headquarter economies, while a high score in the fabrication function is evidence of a country being specialised as a 'traditional' factory economy. In this way, the analysis mirrors the smile curve hypothesis, which claims that R&D (and other knowledge-intensive industries) have a higher potential to capture value added than the fabrication stage of a value chain (Shih, 1996).

While there are parallels in the way functional specialisation affects wages on the one hand and working conditions on the other, we present the underlying economic channels separately, starting with wages.

2.1 Functional specialisation and wages

Figure 1 summarises the relationship between functional specialisation and wages, along with other factors affecting the wages. In a world of GVCs, the functional composition of an economy potentially affects labour market outcomes. More precisely, in line with the above discussion, the hypothesis to be tested is that a specialisation in fabrication activities tends to hold back wage progression, while specialisation in R&D activities has a positive impact on wages.

Figure 1: Functional specialisation, GVC integration and wages



Note: '+' indicates an assumed positive relationship (to be tested); '−' indicates an assumed negative relationship (to be tested).
Source: Adapted from Stöllinger (2019).

The overall effect of functional specialisation on wages may be ambiguous or at least differentiated, depending on the functional position. This is because the fabrication stage (especially assembly) typically requires comparatively fewer skills, so that a large number of countries are potentially capable of taking charge of the fabrication segment of the value chain. Therefore, the fierce competition for gaining a foothold in manufacturing by specialising in fabrication activities of GVC networks will drive down wages in countries specialised as factory economies.

This ‘commodification of manufactures’[7] (Kaplinsky and Farooki, 2010; Kaplinsky, 2019), which concerns the fabrication stage (see also Stöllinger, 2021), is clearly related to the geographical mobility implicit in globally footloose capital through which competing host locations may become locked in a race to the bottom (Farole, 2016).

The situation is different for R&D and other knowledge-intensive functions, because the capabilities required to perform such tasks shield to some extent from competition. If the firms and countries which perform the R&D activities coincide with those that control and orchestrate the production network, they also benefit from their power position within the network. Furthermore, the monopoly profits resulting from successful R&D activities will partly transform into higher wages if they are shared with the worker.

The bottom line is that the different degree of competition in different value-chain functions will affect the wage progression. At this stage this is only an assumption only, but it will be tested in the econometric analysis. If, in contrast to our prior expectations, there is no such differentiation across functions in terms of skills and competition, we will be unable to identify differentiated effects of functional specialisation patterns on wages – or even find no effect at all.

Functional specialisation patterns are unlikely to be the only relevant factor influencing wages in an economy. Rather, numerous other supply, demand and structural factors, including labour productivity – but also unionisation rates, for example – are important. This will be taken into account in the empirical model, as explained in the subsequent section. Moreover, wage effects can also be expected to stem from the intensity of GVC involvement itself. In particular, if MNEs are the carriers of this GVC involvement, a positive wage effect can be expected from the empirical regularity that MNEs tend to pay higher wages than domestic firms. But here, too, tighter economic integration and involvement in GVCs will increase competitive pressures, so that the overall impact of GVC integration is ambiguous.

To sum up, the core reasoning behind this study is as follows: patterns of competition imply that economic rents accrue to intangible assets and organisational capacity (Kaplinsky and Farooki, 2010), especially to firms with control over the ‘commanding heights of GVCs’

7 The commodification of manufactures is in some sense the flipside of compressed development opportunities opened up by global value chains.

(Wade, 2018), while there is comparatively low potential for value-added creation in routine production activities (low-skilled, labour-intensive production, assembly, etc.). This constellation should result in a 'functional burden' arising from an economy's specialisation in the fabrication function in terms of wage development. Conversely, specialising in the R&D function would have the opposite, that is a stimulating, effect.

The *hypotheses* to be tested in this study can be summarised as follows:

- **H1a:** The effect of relative functional specialisation in fabrication on wages is quantitatively different from that of relative functional specialisation in R&D.
- **H1b:** Relative specialisation in the R&D function is positively associated with wages, while relative specialisation in the fabrication function affects wages negatively.
- **H2:** Taking into account the two-way relationship, functional specialisation patterns have a causal effect on wages in EU economies.

Hypothesis H1a and H1b are obviously related, but we split them in two parts. Hypothesis 1a is more general, requiring only differentiated effects of the two polar cases of functional specialisation. Hypothesis 1b is more specific, postulating specific relationships with wages.

As functional specialisation patterns themselves are the outcome of the GVC involvement of countries which are strongly influenced by the wage level, the competition-based channel through which functional specialisation affects wages can be regarded as a feed-back effect, or a magnification effect. However, such a magnification effect can have far-reaching consequences. In particular, it can create lock-in effects, leading to a situation where (relatively) low-wage countries specialise in fabrication activities, which in turn hold back wages further.

It is these feed-back effects of functional specialisation on the wage level and working conditions that we study in this paper, taking into account the two-way relationship between working conditions and functional specialisation profiles.

Such lock-in effects are particularly relevant because they increase the threat of countries getting stuck in a 'functional trap' (Stöllinger, 2019), which adds another aspect to the existing discussions on middle-income traps (e.g. Staehr, 2015; Győrffy, 2022). In the context of EU-CEE economies, while formally high-income countries, it is argued that they may still display features of a functional middle-income trap. This is driven by their persistent specialisations as factory economies within 'Factory Europe', as shown in Kordalska et al. (2022).

2.2 Functional specialisation and non-wage working conditions

Like wages, the effects of different functional specialisation patterns on non-wage working conditions also depend strongly on competition and power relations between firms and countries or regions in value chains. However, the outcome is unclear a priori. One major concern refers to the possibility that competition puts working and employment conditions under pressure, generating a downward spiral and a *'race to the bottom'* (RTB) in labour standards (Chan, 2003). This argument, however, appears to have little empirical support (Guasti and Koenig-Archibugi, 2022). Conversely, competition may also initiate *technological upgrading,* where entrepreneurs invest in new production technologies to keep pace with or even surpass their competitors (Bustos, 2011).

Since newer technologies also tend to be cleaner and less hazardous, workers' physical working conditions may improve. However, other working conditions may deteriorate if, for instance, newer technologies lead to an acceleration in the pace of production or the greater automation of production processes that are increasingly substituting workers for machines and making workers' jobs increasingly insecure (Hammerling, 2022). However, workers who retain their jobs and become more essential in the production process may gain bargaining power that helps them to negotiate better working conditions.

Together with technological upgrading – but also independently – MNEs (as in our case of FDI-based functional specialisation) may export their labour practices to their foreign affiliates, particularly those practices that have a productivity-enhancing effect and therefore provide a competitive advantage over rivals, such as diverse work-life balance practices. There is, however, no empirical evidence in support of this argument, particularly for US MNEs (Bloom et al., 2009; Freeman et al., 2007). A strong role may also be attributable to *consumer pressure,* which could induce producers to comply with higher labour standards throughout global value chains (see Distelhorst and Fu, 2018, for a discussion).

Furthermore, the effects on non-wage working conditions may differ across functional specialisation patterns because of different competitive pressures in different segments of the value chain. According to the RTB theory, the generally higher competition in the less skill-intensive fabrication segment of the value chain may initiate a strong downward adjustment of working conditions. Conversely, it may lead to greater technological upgrading of production processes.

Since production technologies tend to be more diverse – following the 'comparative advantage' theory, more labour-intensive in labour-abundant economies and more capital-intensive in capital-abundant economies – any technological upgrading in the fabrication segment may induce a bigger technological leap, with stronger positive as well as negative effects on different non-wage working conditions.

The situation is different in the R&D segment of the value chain, where competition is 'limited' to those who managed to specialise in this specific function. In this skill-intensive segment, the strong competition for talent makes a 'race to the bottom' less likely but rather leads to a 'climb to the top', which is reflected in the generally better working conditions among highly educated/higher-level workers (Eurofound, 2017a). Moreover, further technological upgrading may induce relatively limited improvements in already better non-wage working conditions, since R&D-related technologies tend to be relatively more homogeneous than production technologies, which makes major technological leaps less likely.

Hence, the *hypotheses* tested for the effect of functionals specialisation patterns on non-wage working conditions can be summarised as follows:

- **H1a:** Relative specialisation in fabrication leads to quantitatively different effects on non-wage working conditions than relative specialisation in R&D.
- **H2:** Functional specialisation patterns have a causal – not necessarily positive – effect on non-wage working conditions.
- **H3:** While the relative specialisation in R&D leads to either zero or small positive effects – 'climb to the top' – the relative specialisation in fabrication can have diverse effects: negative for all working conditions as a result of a 'race to the bottom' or both positive and negative for different non-wage working conditions as a result of technological upgrading.

As in the case of wages, functional specialisation patterns are not the sole determinant of workers' non-wage working conditions. Rather, several other supply-side, demand-side and structural factors play an important role, together with global value chain integration itself. This will be taken into account in the specification of the empirical model that is presented in the following section, along with the sources and specificities of the underlying data.

3. Empirical strategy and data

3.1 Functional specialisation

The empirical analysis relies on two types of measures of functional specialisation. First, the FDI-based approach to functional specialisation – reveals functional specialisations directly from the information on inward cross-border greenfield investment projects and the jobs created through these projects. This is made possible as the information on the function that the (inward) FDI projects serve is provided in the underlying database (see Stöllinger, 2021, for details).

Second, the trade-based approach to functional specialisation, which relies on the methodology proposed by Timmer et al. (2019), relates occupations to value-chain activities. This way, the combination of occupation-level data on labour income with international input-output data can reveal functional specialisation in trade (for details see Timmer et al., 2019).

A commonality of both approaches is that they consider the functional specialisation as a separate dimension that is methodologically unrelated to industries. This allows analysing functional specialisation patterns at the country-industry level. The identified value chain functions in the trade-based and the FDI-based approach to functional specialisation are not exactly the same. However, there is an important overlap in two polar cases of functional specialisation, namely fabrication activities and R&D activities. Hence, for the econometric analysis we rely on these two value-chain functions.

Both approaches allow calculating a relative functional specialisation (RFS) at the country-industry level (in different years), which corresponds methodologically to revealed comparative advantages (RCAs) popular in the trade literature for measuring product or industry specialisations (Balassa, 1965).[8] The twist given to these RCAs is that it is applied to jobs created in inward FDI projects (FDI-based RFS) and wage income flows embodied in trade (trade-based RFS), instead of export flows.

To facilitate the notation, we omit the time subscript in the formal definition of the RFS measure. Denoting value-chain functions by f, the RFS measure of any country c and industry j in value-chain function f is defined as:

8 The economic geography literature interprets RCA as a locational concentration measure, which is called location quotient (LQ) but is mathematically equivalent to the RCA (Hoen and Oosterhaven, 2006).

(1) $RFS_{j,c}^{f} = \frac{J_{j,c}^{f} / \sum_f J_{j,c}^{f}}{\sum_c J_{j,c}^{f} / \sum_c \sum_f J_{j,c}^{f}}$,

where $J_{j,c}^{f}$ is the number of jobs created by greenfield FDI projects (or labour income in trade) serving function *f* in country *c* and industry *j*. Likewise, $\sum_f J_{j,c}^{f}$ is the total number of jobs created by greenfield FDI projects (or the total labour income in trade) in country *c* across all value-chain functions. Analogous definitions apply for the number of jobs in the denominator, where jobs (or labour income in trade) are also summed up over locations to yield the EU-wide number of jobs (or labour income in trade) created by greenfield FDI.

We follow the analysis by Laursen (2015) and use the RFS in a normalised form, so that the values range from −1 (no projects attracted) to +1. The normalised RFS, *normRFS,* is symmetric around 0 and is defined as:

(2) $normRFS_{j,c}^{f} = \frac{RFS_{j,c}^{f} - 1}{RFS_{j,c}^{f} + 1}$.

We also calculate a 'combined' functional specialisation measure, which we label *factory-headquarter ratio* (or *factory-HQ ratio*). It is defined as the ratio between the RFS in fabrication and the RFS in R&D and is also defined at the country-industry level:

$$factory\text{-}HQ\ ratio_{j,c} = \frac{RFS_{j,c}^{fabrication}}{RFS_{j,c}^{HQ}}$$

In line with the individual functional specialisation measure we also normalise the factory-HQ ratio:

$$norm(factory\text{-}HQ\ ratio)_{j,c} = \frac{factory\text{-}HQ\ ratio_{j,c} - 1}{factory\text{-}HQ\ ratio_{j,c} + 1}$$

The fact that our approaches to measure functional specialisation at the industry level is essential for our empirical strategy is because it allows us to estimate an econometric model at the country-industry level over a period of almost 20 years.

We proceed by presenting the empirical models for the effects of these measures of functional specialisation on wages and non-wage working conditions.

3.2 Wage regressions

3.2.1 Model specification

In contrast to the marginal productivity theory of wages, the bargaining theory of wages upholds that there is no single economic principle or force governing wages. Rather, wages and other working conditions more generally are the result of negotiations between workers and employers, possibly with the intermediation of labour unions. The outcome of these negotiations depends on the bargaining position of the negotiating parties, which in turn depends on a myriad of factors.

Since the wages of workers in individual occupations were shown to vary considerably across industries even when controlling for union membership (Dickens and Katz, 1987), industry-specific factors must be suspected to play an important role. In view of our theoretical framework we would subsume the functional specialisation *within* an industry as one of the relevant factors, along with more traditional industry characteristics such as industry size, the average size of firms or the share of female employment.

This is not to argue that labour productivity and human capital, which are stressed in the marginal productivity theory of wages, are irrelevant (Becker, 1962). These will be taken on board, as the relevance of productivity and the level of education for the wage level is undisputed.

For this reason we follow the empirical literature on wage determination, which suggests that both supply and demand factors contribute to wage differentials (McCausland et al., 2020; Du Caju et al., 2010). In addition to supply-side and demand-side factors (which include structural factors) we also include the unionisation rate as a measure for labour market institutions (e.g. Krueger und Summers, 1988), although the results on the relevance of institutional factors in explaining wage differentials across industries are mixed (e.g. Krueger and Summers, 1988; Zweimüller and Barth, 1994; Wagner 1990).[9]

All models will be estimated at the country-industry level for the period 2000–2014 (trade-based measures) and 2003–2019 (FDI-based

9 Wagner (1990) identifies no similarity in the industry-level wage structure across five industrialised countries, which is consistent with the claim that national labour market institutions affect wage differentials across industries. In contrast, Krueger and Summers (1988) found that such similarities even exist between (former) socialist and capitalist economies. This result questions that national labour market institutions play an important role in determining industry-level wages. Similarly, Zweimüller and Barth (1994) report rather homogeneous wage patterns across countries, even when controlling for labour quality, therefore coming to the same conclusion as Krueger and Summers (1988).

measures), respectively. As further described below, we rely on an instrumental variable approach for the main explanatory variables to tackle the reverse causality between functional specialisation and wages. In order to further reduce reverse causality, we also use the first period lag of all explanatory variables. In its most general form, the model takes the following form:

$$(3)\quad w_{j,c,t} = \alpha + \underbrace{\beta^{RFS} \cdot RFS_{j,c,t}}_{\text{Functional specialisation measures}} + \underbrace{\beta^{S} \cdot S_{j,c,t}}_{\text{Supply factors}} + \underbrace{\beta^{D} \cdot D_{j,c,t}}_{\text{Demand factors}} + \underbrace{union_{c,t} \cdot \gamma}_{\text{Labour market institutions}} + \varepsilon_{j,c,t}$$

where $w_{j,c,t}$ is the annual real wage (in logs) in industry *j* and country *c* at time *t* and $RFS_{j,c,t}$ may be any of the various functional specialisation measures described in Section 3.1.[10] Several variants in which the RFS for fabrication and R&D will enter the regression either individually or simultaneously will be estimated. Our combined measure for functional specialisation, $Factory - HQ - Ratio_{j,c,t}$, necessarily enters the regression separately. All specifications are run separately for the trade-based and the FDI-based measures.

In view of the two hypotheses put forward in Section 2, we have clear expectations regarding the coefficients β^{RFS}. Hypothesis 1 stipulates a differentiated wage effect of the RFS in fabrication and in R&D. The first part, hypothesis 1b, requires that the estimated effects for RFS in fabrication and of the RFS in R&D are significantly different from each other, which can be established with a Wald test for equality of the coefficients of the RFS measures.

Hypothesis 1b is more demanding, requiring a positive sign for the RFS in R&D and a negative sign for the RFS in fabrication to be confirmed. Hypothesis 2 proposes that functional specialisation is having a causal effect on the wage level and that any effects captured are not the result of reverse causality and therefore spurious.

The main methodological challenge for our empirical model and for testing the hypotheses (especially hypothesis 2) is the two-way relationship between functional specialisation and wages, respectively working conditions. To tackle this issue, we carefully construct instrumental variables for relative functional specialisation measures based on the values for these measures of out-of-sample countries.

This ‘other country’ instrumental variable approach has become popular in the trade literature – for example to instrument for import

10 In principle $RFS_{j,c,t}$ may contain a set of variables but to ease notation we describe it as a single variable. The same applies to the other set of explanatory variables.

competition (Autor et al., 2013) – and has recently also been applied by Cherif et al. (2018) in a growth regression context and in Parteka and Wolszczak-Derlacz (2020) in a wage model. In the latter contribution the growth regressors are instrumented by the average of the neighbouring countries in the sample. We follow a similar strategy but further strengthen the exogeneity of the instruments by using only RFS values from non-EU countries, that is, from countries which are not part of our sample.

More precisely, we construct instruments for RFS in fabrication and RFS in R&D at the country-industry level. For this we take for each country-industry (e.g. Austria in the food, beverages and tobacco industry) the values of the five out-of-sample countries which have the highest correlation over time in that industry. Based on these values we calculate the unweighted and the correlation-weighted instrument of the five 'closest' countries. In addition, in order to be able to test the exclusion restriction for the instruments, that is, that the instrument is uncorrelated with the error term $\varepsilon_{j,c,t}$ in regression equation (3), the RFS values of the 'instrument countries' are also used individually.

However, we restrict the number of instruments to three countries for each RFS measure. This way, the number of instruments exceeds the number of endogenous regressors and the regression is overidentified, so that it is possible to test for the exogeneity of the instruments using the Hanson test statistics.[11] We apply this instrumental variable strategy in the wage regressions for both RFS measures. Unfortunately, because the instrument turns out to be valid only in the case of the FDI-based indicators, we only present results for those. The first stage regressions, including the tests for the variable instruments, are reported in the Appendix.

Methodologically less challenging but equally important is the minimisation of any potential omitted variable bias. For these, a set of country-, industry- and time-fixed effects are included in the regression, but a series of supply-side factors, $S_{j,c,t}$ and (broadly defined) demand-side factors, $D_{j,c,t}$, which can be expected to affect wage levels and working conditions, is also included.[12] The control variables are discussed below.

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11 The null hypothesis for the Hanson J test is that the instruments is exogenous. Hence, the instrument is valid if this hypothesis is not rejected.

12 Some of these demand-side and supply-side control variables, such as the unionisation rate, are only available at the country level and therefore do not have an industry dimension *j.*

3.2.2 Supply-side factors

Labour productivity

The effects of GVCs on productivity have been studied in the literature (e.g. Kummritz, 2016; Criscuolo and Timmis, 2017; Taglioni and Winkler, 2016). As we are interested in the effects on wages and working conditions, the rationale for including labour productivity in the regression is slightly different. It captures simply the – presumably very strong and positive – impact of labour productivity on wages as predicted by the marginal productivity theory of wages (see e.g. Farole, 2016). Given the supposedly strong relationship between wages and labour productivity, this sets a high bar for finding significant effects for any of the other explanatory factors, including the RFS measures.

Human capital index

The human capital stock is one of the main supply-side determinants of wages as it reflects the number of years individuals have 'invested' in education, that is in neoclassical terms, in human capital. The expectation is that better educated workers earn higher wages even when controlling for productivity because of the return to education, which can be interpreted as the return on investment in human capital. Hence, the higher the human capital stock, the higher the wages. While returns to education accrue at the level of individuals, the effect will translate to the country level, so that we expect a positive coefficient for the human capital stock.

Skilled to unskilled labour ratio

An additional control is the ratio between skilled and unskilled workers. The differentiation between low-, medium- and high-skilled labour is based on the educational attainment of workers. The skilled to unskilled labour ratio is supplementary to the human capital stock variable and has the advantage that it has variations across industries. It is similar to the control for the share of workers with university education in the wage regression of McCausland et al. (2020). We expect a higher ratio to have a positive impact on wages.

3.2.3 Demand factors, including structural factors

Forward and backward GVC participation

The theoretical framework showed that countries' integration into GVCs does not only allow for functional specialisation but may also affect wage levels. We use the common measures for forward and backward participation in GVCs as defined by the OECD (Martins Guilhoto et al., 2022). The backward GVC participation rate is the share of foreign value added contained in a country's exports as a percentage of gross exports, while the forward GVC participation rate is the share of a country's exports that in turn form part of trading partners' exports, expressed as a percentage of gross exports.

By definition, GVC participation includes exclusively trade in intermediate goods. Both measures are trade-based and are defined at the country-industry level. The forward and backward GVC measures are complex indicators, which capture first of all trade flows but indirectly also the importance of foreign multinationals in an economy, as these firms have high import and export intensities. The involvement of foreign MNEs would suggest that GVC participation leads to higher wages (because foreign MNEs are more productive and pay higher wages). Moreover, GVCs allow countries to specialise according to their comparative advantages, which could also translate into higher wages.

In contrast, GVC integration may also have an adverse effect on wages because of international competition. This is particularly true for backward GVC participation, which is by definition a measure of imported intermediate goods. Therefore, the overall effect of GVC participation is ambiguous.

Outward-to-inward FDI ratio

The outward-to-inward FDI ratio is a further indicator related to foreign direct investment and GVCs. The measure is defined at the country level[13] and is normalised to lie between −1 and +1. The measure is closely related to the functional specialisation measures, because there is a strong positive correlation with RFS in R&D and a strong negative correlation with the RFS in fabrication.

The inclusion of this measure is therefore mainly a test of whether the functional specialisation measures have any explanatory power beyond FDI inward and outward stocks. Since the outward-to-inward FDI ratio is a country-level indicator, it captures to some extent also a country's stage of development.

Job vacancy rates

Inspired by the carefully designed measure for macroeconomic yet industry-specific labour demand in McCausland et al. (2020, p. 109), va-

13 We also retrieved country-industry level FDI data from Eurostat and calculated a corresponding FDI ratio. However, the variables turned out to be irrelevant in the regression model. This is why we opted to include the FDI ratio at the country level.

cancy rates at the country-industry level are included in the model to account for labour market conditions.[14] The vacancy rate is a measure for the level of labour demand. If open positions are abundant in an industry, as reflected in vacancy rates, the demand for labour is relatively high compared with labour supply. Therefore, high vacancy rates within an industry tend to push up wages, everything else being equal.

Long-term unemployment

Yet another measure for the labour market situation is the share of unemployed persons in the overall labour force. We focus on the long-term unemployment rate – defined as persons who have been unemployed for twelve months or more – because this indicator also contains a structural element. Hence, the long-term unemployment rate reflects to a stronger extent the skills mismatch between available workers and the requirements of the labour market, which feeds into the number of people unable to find a job over a longer time period. We expect the long-term unemployment rate to be negatively related to wages.

Industry-level employment

The bargaining position of an industry may depend inter alia on its economic importance. In line with this reasoning and the approach in McCausland et al. (2020), our model includes industry-level employment (in log form) as a control for industry size. The expectation is that larger industries pay higher wages.

Employment share of manufacturing

While the analysis is limited to manufacturing industries, we still want to control for the total size of the manufacturing sector in the total economy. In principle, we expect a priori a positive relationship between the share of manufacturing and wages given the special features of the sector, one of which is the fact that it tends to pay higher wages (see Rodrik, 2011, on the 'manufacturing imperative'). However, since we control for many additional characteristics, we remain agnostic as to the effect of the employment share of manufacturing.

Female employment share

There is ample evidence that females are discriminated against in the labour markets in various forms. We attempt to capture one of the numerous facets by including the share of females in total employment at the country-industry level. Having this information at the industry level is

14 Unfortunately, for EU member states detailed information on the labour flows in and out of specific industries is not available.

essential, as there is quite some variation of female employment shares across industries. For example, female employment tends to be large in the textile and garment industry, while it is low in the automotive industry. The expectation is that industries with a higher share of female employment pay lower wages.

Firm exit and entry rates (churning)
The entry and exit rates of firms, which taken together are referred to as business churning, are an enterprise-related structural feature of industries. We use it as a measure for the dynamics of the firm demography. According to Schumpeter's famous concept of creative destruction, the exit of unproductive firms in combination with new entrants flowing into the industry can be seen as a sign of health and the proper functioning of the competitive process in a market economy.

Therefore, we may expect that higher business churning rates in an industry are associated with higher wages. At the same time older, long-established firms tend to pay higher wages, suggesting a negative relationship between churning and wages. Therefore, the overall relationship between churning and wages is a priori undetermined.

3.2.4 Indicators for labour market institutions

Unionisation rates
The extent to which employees are organised in and represented by labour unions is one of the key characteristics of the labour market. Union density – the unionisation rate – is certainly a structural feature of the economy, but labour unions are also a key institution in European economies, and we rather associate the unionisation rate with labour market institutions.

The expected effect of unions is straightforward: since unions allow for collective bargaining vis-à-vis employers (or employer organisations), they improve the bargaining position of labour, which should result in higher wages.

3.3 Empirical model for other non-wage working conditions

3.3.1 Model specification

For the analysis of other working conditions we apply a similar model specification as for the wage model outlined in equation (3) above and include in addition to the two functional specialisation measures for fabrication and R&D both supply- and demand-side factors as well as the unionisation rate as a measure for labour market institutions.

However, since the key underlying data source for other working conditions – Eurofound's European Working Conditions Survey (EWCS; see Section 3.4 below) – is available at the level of the individual worker, the analysis of other working conditions differs from the above analysis of wages in important respects. First, the analysis is undertaken at the detailed country-industry-worker level. Second, we also include in our model different worker and firm characteristics as additional controls that either replace or complement some of the industry-level factors used in the wage model.

Third, instead of a longer time series we use a pooled sample of the two latest available EWCS waves conducted in 2010 and 2015, since the change in the NACE classification between 2007 and 2008 makes any previous EWCS waves incompatible with the NACE classification used in the calculation of the two functional specialisation measures. And finally, we focus on the two FDI-based functional specialisation measures, which allows us to make use of two EWCS waves instead of only one, as in the case of the trade-based measures, which are only available until 2014 and would leave us with only one EWCS wave for the analysis.

In view of this, we estimate the following specification[15]:

$$(4)\ wc_{i,j,c,t} = \alpha + \underbrace{\beta^{RFS} \cdot RFS_{j,c,t}}_{\textit{Functional specialisation measures}} + \underbrace{\beta^{WF} \cdot WF_{i,j,c,t}}_{\textit{Worker \& firm factors}} + \underbrace{\beta^{S} \cdot S_{j,c,t}}_{\textit{Supply factors}} + \underbrace{\beta^{D} \cdot D_{j,c,t}}_{\textit{Demand factors}} + \underbrace{\gamma \cdot union_{c,t}}_{\textit{Labour market institutions}} + \varepsilon_{i,j,c,t}$$

15 As in the wage model, we write the regression equation as if each of the set of explanatory variables were a single variable for ease of notation.

where $wc_{i,j,c,t}$ refers to one of six working conditions of worker *i* in industry *j* and country *c* at time *t.* Specifically, we use a polychoric principal component analysis to construct from different questions in the EWCS composite indicators for the following six working conditions following Eurofound (2017a): (i) physical environment, (ii) work intensity, (iii) working time quality, (iv) social environment, (v) skills and discretion, and (vi) prospects. The validity of each of the composite working condition indicators is tested by means of exploratory and confirmatory factor analyses, and items with low factor loading and/or which show little internal consistency with the other items in a group were removed from each indicator.

Moreover, since we also only use survey questions that are included in both surveys, our composite indicators differ somewhat from the ones specified in Eurofound (2017a). The full list of questions is available in Table 11 in the Appendix.

Furthermore, given the nature of the underlying questions, the six working conditions need to be interpreted as follows: an increase in the score on the (i) physical environment, (ii) work intensity, (iii) working-time quality and (iv) social environment should be interpreted as a deterioration, and an increase in the scores on (v) skills and discretion and (vi) prospects as an improvement. $RFS_{i,c,t}$ refers to the two FDI-based functional specialisation measures described in Section 3.1, which we use jointly in our analysis.

$WF_{i,j,c,t}$ refers to different worker and firm characteristics, $S_{j,c,t}$ to a set of supply-side factors and $D_{j,c,t}$ to different demand-side factors, $union_{c,t}$ to labour market institutions and $\varepsilon_{i,j,c,t}$ to the error term. The control variables are briefly discussed below.

Except for all EWCS-based indicators, the data are differenced to take into account that changes take time to materialise. We use three different differencing periods – one year, two years, three years – which allows us to determine and compare the effects of short versus longer-term changes on workers' working conditions.

We do not consider longer differencing periods beyond three years, as the number of missing observations in the two functional specialisation measures increases and the results become difficult to compare. By contrast, the EWCS-based indicators cannot be differenced, as they are observed at the level of the individual worker and the EWCS is not designed as a panel where the same workers would be (re-)interviewed in some (or all) EWCS waves.

Methodologically, we apply a multilevel regression model to take into account that the different working conditions (plus other worker and firm characteristics) are available at the individual level, while the two functional specialisation measures (plus other controls) are available at the industry or country level. Hence, we can appropriately incorporate explanatory variables at all three levels of aggregation and separately consider the within and across country and industry variation. This not only improves the estimates' efficiency (Gelman and Hill, 2006) but also produces unbiased estimates.

The likelihood ratio tests we conduct suggest that the variation across countries and industries is sufficient to use a multilevel model instead of an ordinary linear model. It also helps us to reduce the potential reverse causality problem of the two functional specialisation measures highlighted above, since we can expect that while functional specialisation affects workers' working conditions, conversely, individual workers' working conditions have a much smaller effect on functional specialisation. However, we do not use industry- or country-fixed effects, since our interest is primarily in modelling industry-level (but also country-level) processes.

3.3.2 Worker characteristics

Gender

Women are often found to be disadvantaged on the labour market: not only do they earn less than men – even after controlling for other characteristics (Christofides et al., 2013; Nicodemo, 2009; Olivetti and Petrongolo, 2008) – but their working conditions are also often worse than for men. In particular, due to traditional gender roles household and caring responsibilities are still predominantly in the hands of women, and because of the risk of (or actual) career interruptions employers tend to be more reluctant to invest in the development of their skills or to offer good career prospects to their female employees.

Women also tend to experience more frequently adverse social behaviour in terms of verbal abuse, unwanted sexual attention, humiliating behaviour, sexual harassment etc. In contrast, women seem to have an advantage over men in other respects: they are less likely to work under physically harsh and demanding working conditions and are more likely to hold jobs that are characterised by lower work intensity or higher working-time quality (Eurofound, 2017a).

We include a dummy for females (while males serve as reference group) and expect similarly differentiated results that favour women in terms of physical environment, work intensity and working-time quality but disadvantage them in terms of skills development and job and career prospects.

Immigrant

Immigrant workers are often over-represented in less desirable, less skilled jobs and thought to be more strongly exposed to unfavourable working conditions, which is traced back to the greater difficulties they face in entering the labour market or in having prior educational and technical training validated in the host country, their poor language skills, and labour shortages in some unskilled occupations.

Empirical evidence seems to suggest that while there is little evidence that immigrant workers tend to be more exposed to physical or chemical hazards and poor psychosocial working conditions than natives, they experience more frequently bullying and perceived discrimination and face a higher risk of work-related injuries than native workers (Sterud et al., 2018). We include a dummy which is equal to one if a person was born outside the residing country (with native-born as reference category) and also expect negative effects associated with immigrants' social work environment.

Age

In the context of ageing societies in Europe (but also world-wide), the relationship between the quality of working conditions and age has become a concern as it brings to the fore the question of the sustainability of work among older workers and the role of working conditions in prolonging working life. Empirical evidence tends to show that older workers seem to operate under more favourable working conditions than their younger peers: they are less likely to be in physically harsh and demanding working conditions, to be working at very high speed or to tight deadlines, to be exposed to adverse social behaviour, or to be working longer hours. They also enjoy more flexible working-time arrangements.

However, older workers are found to be in a less favourable position in other respects: they are less likely to participate in training, to learn new things on the job or to see good opportunities for career advancement (Eurofound, 2017b). Age is included by means of dummy variables for the young (aged 15–24 years), those in their prime age (25–49 years) and those aged 50 and above (as reference category). We do expect a similarly differentiated pattern with age-related advantages in some working conditions but disadvantages in others.

Occupation

For several reasons, higher-level occupations are thought to be associated with better working conditions. For instance, since skilled task activities are usually more difficult to monitor in detail, skilled workers tend to have greater scope for initiative and autonomy in the work process. Furthermore, skilled workers tend to possess specialist knowledge that is key for the functioning of the organisation.

Hence, the withdrawal of their cooperation would cause substantial costs for firms. Skilled occupations also tend to be in higher demand on the labour market, which prompts employers to provide working conditions that are sufficiently attractive to retain these workers over time. The empirical literature generally corroborates a positive relationship between the level of skills and the quality of working conditions. Especially relevant are the results from the 2015 EWCS, which show that more highly skilled workers had better jobs in terms of the physical work environment, skills and discretion, career prospects and earnings (Eurofound, 2017a).

We operationalise occupation by means of the 1-digit International Standard Classification of Occupations (ISCO-08) and capture it in terms of dummy variables for low occupations (as reference group; levels 8–9 for machine operators and workers in elementary or routine occupations), medium occupations (levels 4–7) and high occupations (levels 1–3 for managers, professionals and technicians). In line with the empirical literature, we expect that higher-level occupations face better working conditions.

3.3.3 Firm characteristics

Firm size

Scant empirical evidence shows that working conditions also depend on firm size. For instance, workers in larger firms tend to face greater rigidity in the organisation of their work as they have less influence on the range of tasks they do, over their pace of work or how they do their work (Idson, 1990; Garcia-Serrano, 2011; Tansel, 2022). This is in contrast to the more flexible working-time arrangements they enjoy in terms of the availability of parental leave, working from home or job sharing (Tansel, 2022).

We test the role of firm size for different working conditions by including dummies that are equal to one if a firm is either micro or small (reference category; 1–49 employees), medium-sized (with 50–249 employees) or large (with 250 or more employees). We expect differentiated results across the different working conditions considered.

Firm ownership

Working conditions also relate to ownership structure. In this respect, the need to be competitive and to generate profit differentiates the private from the public and puts more pressure on private-sector firms. Employees in public-sector firms benefit from general labour law and particular collective agreements which regulate their working conditions. Results from the 2015 EWCS highlight that workers consider working conditions in the public sector to be more attractive than in the private sector.

Specifically, workers in the public sector experience less exposure to physical risks, relatively low levels of work intensity, regular and more flexible working hours, a high degree of job autonomy and high levels of employment security and employer-funded training (Eurofound, 2014). We include dummies that are equal to one if employees either work in the public sector (as reference category), the private sector or in other organisations (joint private-public organisation or company; not-for-profit sector or NGO; other – not specified) and expect equally favourable working conditions among workers in the public sector.

3.3.4 Supply-side factors

Labour productivity

Labour productivity is equally important also for other (non-wage) working conditions, whose change could be a blessing or a curse. Specifically, if induced by technological upgrading and the implementation of cleaner and less hazardous technologies, increases in labour productivity may improve workers' physical working conditions. Equally, workers may gain bargaining power from a technology-induced increase in labour productivity if they become more essential and indispensable in the production process (Betcherman, 1991; Brock and Dobbelaere, 2006).

Conversely, both technology- and efficiency-induced increases in labour productivity may lead to a deterioration of some working conditions if, for instance, newer technology leads to an acceleration of production processes and more intense work demands in terms of a faster work pace.

3.3.5 Demand-side factors

Forward and backward GVC participation

Generally, the very limited empirical evidence on the linkages between GVC integration and non-wage working conditions in Europe tends to be country- or industry-specific and suggests highly diversified effects, depending strongly on the measures and the industry/country or country-groups analysed (Hummels et al., 2016; Smith and Pickles, 2015; Lloyd and James, 2008).

The two studies closest to ours – both in terms of the cross-country sample and the methodological approach – find that workers in industries that are more intensely integrated into GVCs have less stable earnings but are also less likely to work overtime (Nikulin et al., 2022) and are less likely to work under temporary employment contracts, with marked differences across the countries in the sample (Nikulin and Szymezak, 2020). Similar to the above arguments regarding the wage effects of GVC integration, a stronger (forward and backward) participation in GVCs can have diverse effects.

For instance, stronger participation in forward linkages may result in better working conditions in supplying firms if (reputation-sensitive) MNEs put pressure on their suppliers to improve their employees' working conditions. Conversely, a stronger participation in backward linkages and the associated increase in competition may lead to a deterioration of working conditions in the context of a 'race to the bottom'.

It may, however, also induce technological upgrading and investments in more sophisticated (less hazardous) technologies, which helps to improve some working conditions mainly related to physical health risks and physical demands.

Job vacancy rate

An increase in the industry-level vacancy rate reflects an increase in the number of open positions that cannot be filled with the available labour supply. In this situation of excess labour demand workers tend to gain bargaining power, which should help them to negotiate for better working conditions.

Long-term unemployment

Conversely, an increase in the long-term unemployment rate is characteristic of growing structural labour market issues in terms of job mismatches, which may weaken the bargaining power of workers (due to a deterioration of their outside options) and lead to worse working conditions.

Industry-level employment

An increase in the size of an industry may be associated with an increase in the relative bargaining position of workers, which should, in turn, result in better working conditions.

Employment share of manufacturing

Working conditions generally differ across sectors, with some evidence that certain working conditions are worse in industry[16] than in other sectors in terms of high work intensity, low skills and discretion, or a relatively unfavourable physical working environment, for example (Eurofound, 2020). Hence, a further increase in the size of the manufacturing sector may translate into a proliferation of unfavourable working conditions.

Firm exit and entry rates (churning)

An increase in business churning, particularly if driven by an increase in a firm’s entry rate, may lead to better working conditions, as new firms bring with them new technologies that tend to be cleaner and physically less hazardous. At the same time, more business churning is associated with more uncertainty and may lead to less stable jobs, more frequent work interruptions and potentially worse career prospects.

Real GDP per capita

The level of economic development is also closely related to prevailing working conditions, such that non-wage working conditions should also improve if an economy prospers.

3.3.6 Labour market institutions

Unionisation rates

Similar to the above argument, we expect that an increase in the unionisation rate leads to a better bargaining position for workers and thus to better working conditions.

3.4 Data and descriptive statistics

Wages

Wages are derived from dividing industry-level data on the nominal labour compensation and number of employees from Eurostat’s Structural Business Statistics (SBS). We take into account the change in industry classifications from NACE Rev. 1 to NACE Rev. 2 in 2008, using a correspondence table to obtain a time series running from 1995 to 2019. As

16 Industry is composed of Mining and quarrying, Manufacturing, Electricity, gas, steam and air conditioning supply, and Water supply, sewerage, waste management and remediation activities.

certain industries in the SBS were particularly prone to a large number of missing observations, these had to be filled relying on other data sources.

Hence, where information was unavailable, we supplemented the SBS dataset with the employment and compensation data accompanying the OECD Inter-Country Input-Output (ICIO) database. Given methodological differences, however, the two datasets are not entirely comparable. Therefore, rather than filling the missing values in the SBS with data from the ICIO data directly, we derive the growth rates of the respective ICIO values over time and use these growth rates to impute the missing values in the SBS dataset.

Since ICIO data only contain information up to the year 2018, missing values for 2019 are inferred based on the growth rates of the overall manufacturing sector (C) taken from SBS. All values are deflated to obtain real 2015 values using national harmonised consumer price indices (HCPI).

Working conditions

The information on other (non-wage) working conditions stems from Eurofound's European Working Conditions Survey (EWCS), which was launched in 1990 and has since been conducted every five years in a growing number of European countries (EU member states, EU candidate countries, EFTA countries).[17] The EWCS is particularly suited for this analysis as it provides detailed information on the working conditions of workers (employed and self-employed) in Europe, which is used to construct six different composite working condition indicators in line with Eurofound (2017a; see above).

The survey is carried out by means of face-to-face interviews using computer-aided personal interviewing (CAPI) with a sample size that varies between a required minimum of 1,000 and over 3,000 persons per country. In each country a multi-stage, stratified clustered sampling design is used, with stratification based on geographical regions (NUTS 2 level or below) and a degree of urbanisation.

Three types of weights are applied to guarantee that the results can be considered to be representative for workers in Europe: design weights to adjust for different selection probabilities in the multi-stage sampling design; post-stratification weights to ensure that the sample

17 So far, seven editions of the EWCS have taken place, in 1991, 1995, 2000/2001, 2005, 2010, 2015 and 2021 in a growing number of European countries. Owing to the COVID-19 pandemic, the EWCS 2021 'extraordinary edition' was conducted by computer-assisted telephone interviewing (CATI) in 2021. Results have been published since November 2022.

accurately reflects the socio-demographic structure of the target population; and cross-national weights to adjust for differences in sample size and to ensure that each country is represented in proportion to the size of its in-work population.[18]

Generally, the sample used in the EWCS is representative of individuals aged 15 and over,[19] living in private households and in employment (i.e. who did at least one hour of work for pay or profit during the week before the interview took place, from Monday to Sunday). Detailed information about workers' industry affiliation (according to the 2-digit NACE Rev. 2 classification) is used to match the EWCS with other industry-level data, most importantly the two functional specialisation measures for fabrication and R&D.

The ensuing analysis on other working conditions only uses the 5th and 6th waves of the EWCS, which were conducted in 2010 and 2015, respectively, since the break in the NACE classification between 2007 and 2008 makes previous waves incompatible with the NACE Rev. 2 classification used for the calculation of the two functional specialisation measures as well as other industry-level information used in the analysis.

The sample of the present study includes all EU member states (except Cyprus, Malta and Luxembourg) and includes those participants who were employed at the time of the survey. We excluded the group of self-employed for whom some of the key underlying questions were not available since they were only addressed to employees.

Trade-based functional specialisation

The trade-based RFS relies on the international input-output tables from the World Input-Output Database (WIOD) Release 2016 (Timmer et al. 2015) to calculate the domestic value added in trade. The WIOD contains information about input-output flows, final demand, gross value added and gross output for 43 countries and the rest of the world, and for 56 industries according to the NACE Rev. 2 classification.

Given the coverage of the data, this measure is available for the period of 2000–2014. The information from the WIOD is combined with data on employment and labour compensation for 13 occupations across European countries at the industry level, which have kindly been provided by Timmer et al. (2019) and Buckley et al. (2020).

18 For more information on sampling, see the sampling implementation report on the EWCS-2015: www.eurofound.europa.eu/sites/default/files/ef_survey/field_ef_documents/6th_ewcs_2015_-_sampling_implementation_report.pdf (Accessed 13 April 2023).

19 Sixteen and over in Bulgaria, Norway, Spain and the UK.

FDI-based functional specialisation

The information for calculating the FDI-based RFS is obtained from the cross-border investment monitor fDi Markets, maintained by the Financial Times.[20] The underlying database compiles individual greenfield FDI projects and major extensions from 2003 onwards.[21]

Since the database is composed of single greenfield FDI projects, a large number of characteristics of the individual greenfield FDI are available, including the investor company, the name of the subsidiary established, the origin and destination locations of the project, as well as the industry affiliation. Of these characteristics we exploit in particular information on the purposes for which the subsidiary was established, i.e. the business (or value-chain function) it serves.

These functions labelled 'activities' in the database, largely correspond to business functions that can be used directly for the categorisation of projects by functions. This way, greenfield FDI projects are assigned to one of the following five groups of value-chain functions: (i) *headquarter services,* (ii) *R&D,* (iii) *fabrication,*[22] (iv) *sales and distribution services* (including sales, logistics, marketing, business services), and (v) *technical support services and training.*[23]

The information on value-chain functions is available at the industry level, although the industry classification of the fDi Markets database had to be mapped to NACE Rev. 2 industry classification.[24] Another advantage of this database is that it is global in scope, which enables us to collect not only data on the countries in the sample but also for a large number of additional countries (from a FDI-destination country perspective) and use this information to construct our instruments for the endogenous RFS measures.

20 See: www.ftspecialist.com/fdi_markets.html (Accessed 13 April 2023).

21 The database only records new investment projects, referred to as greenfield investments, as well as major extensions of existing projects. The records reflect the announcement of new investments. Hence, it may well be that some of the projects do not materialise. According to the Financial Times, the database is regularly updated and cleaned from unrealised projects. In order to minimise the number of projects which in the end do not materialise, the sample period is limited to 2015, despite the fact that more recent data have become available.

22 We use the term 'fabrication' when referring to the actual production stage of the (much wider) manufacturing process. This choice of terminology is that fabrication, though less common in English, makes it clear that it does not mean the entire production process in a generic sense but the specific production stage (or one of the production stages).

23 The details of the mapping of the activities according to the fDi Markets database, along with three, respectively five-pronged groupings, are provided in Appendix A.1.

24 Details on the mapping of 'activities' into value chains functions and of the fDi Markets industries into NACE Rev. 2 are provided in Kordalska et al., 2022.

Forward and backward GVC participation

Data for the backward and forward participation measures are taken from the 2021 edition of the OECD Inter-Country Input-Output (ICIO) database.[25] The international input-output tables of the OECD ICIO database allow for the calculation of the GVC participation measures. We retrieved these with the help of the four-dimensional trade flows, provided by the OECD (EXGR_BSCI measure) and described in more detail in Martins Guilhoto et al. (2022). Since the OECD ICIO ends in 2018 we imputed the values of 2018 for the year 2019.

This appears to be permissible as GVC integration came to a halt around 2015 (or earlier), and since then few dynamics in key GVC participation indicators have been observable.

Labour productivity

We obtain industry-level labour productivity in a similar way to the steps described above related to wages. The relevant information has been taken from Eurostat's SBS, namely value added and number of employees, and has been complemented with the corresponding data from the OECD ICIO. Here, too, we relied on the respective growth rates of the ICIO data (value added and number of employees) to fill in the gaps of the SBS dataset. In turn, labour productivity is calculated as the value added per employee. In order to be aligned with wages, labour productivity was deflated using the country-level HCPI to obtain real 2015 values.

Human capital index

The human capital stock is obtained from the Penn World Tables (PWT) 10 (Feenstra et al., 2015).[26] Following human capital literature (e.g. Caselli, 2005), the human capital index in the PWT 10 reflects the rate of return to education resulting from a Mincer wage regression applied to the average years of schooling (Barro and Lee, 2013).[27]

Skilled to unskilled labour ratio

The data on the educational attainment of workers by educational attainment according to the International Standard Classification of Education (ISCED) are not generally available for EU countries. Therefore, we had to take recourse to the first generation of the Socio-Economic Ac-

25 Available at: www.oecd.org/sti/ind/inter-country-input-output-tables.htm (Accessed 13 April 2023).
26 Available at: www.rug.nl/ggdc/productivity/pwt (Accessed 13 April 2023).
27 Details on the construction of the human capital index can be found in the note on the construction of Human capital in PWT 9.0 (and PWT 10), available at: www.rug.nl/ggdc/docs/human_capital_in_pwt_90.pdf (Accessed 13 April 2023).

counts (SEA) of the World Input-Output Database (WIOD 2013 Release).[28] The SEA of the WIOD 2013 Release contain information on employment of high-, medium- and low-skilled workers for the period 1995–2009.

An inspection of the data suggested that the variation is often not across industries but by industry groups by technology content. Nevertheless, the SEA of the WIOD 2013 is the most suitable source of data on employment by skills. We complement the data beyond 2009 with the country-level data on employment by skill groups from Eurostat. Hence, the trends over time within any country is the same for all industries for the period 2010–2019. Given the data constraints, this is a limitation we have to accept.

Job vacancy rates

The job vacancy rates are taken from the European Labour Force Statistics (LFS) available at Eurostat. Job vacancies are defined as a paid post that is newly created, unoccupied, or about to become vacant. What is actually used in the empirical model is the job vacancy rate, which is defined as the share of job vacancies in total posts (i.e. the sum of the number of occupied posts and the number of job vacancies), expressed as a percentage.

Information about job vacancy rates in EU member states is available at the level of 1-digit NACE industries, which in our context means at the level of manufacturing. When information on job vacancy rates for the manufacturing sector is not available (for more distant years in Spain), we use the vacancy rates of the (broadly defined) industrial sector, including mining, manufacturing, utilities and construction, or the total economy except agriculture or the total economy instead (in that order). In addition, we need to fill some missing values with the average rate of change in the vacancy rate of those countries for which all data are available.

Long-term unemployment

The information on unemployment is taken from Eurostat's unemployment statistics. Unemployed persons are all persons aged 15–74 years who were not employed during the reference week but were actively seeking work and were readily available for the labour market (within two weeks). What is actually used is the long-term unemployment rate, which is the share of persons unemployed for twelve months or more as

28 Available at: www.rug.nl/ggdc/valuechain/wiod/wiod-2013-release?lang=en (Accessed 13 April 2023).

a percentage of the labour force. We impute the (few) missing values in more distant years with the value of the subsequent year.

Industry-level employment

As alluded to in the descriptions of wages and labour productivity, we obtain information regarding the number of employees in individual countries' industries by combining data from Eurostat's SBS and the OECD's ICIO. For our analysis we take the absolute number of employees (V16130 in SBS), which includes all persons contractually employed in the given sector receiving compensation (wages, salaries, fees, gratuities, piecework pay or remuneration in kind). To address the issue of missing observations in the SBS, we rely on information from the OECD's ICIO to fill the gaps, using the steps described above (see section on 'Wages' above).

Employment share of manufacturing

Information on the share of employment of the manufacturing sector in the total economy is taken from Eurostat's System of National Accounts Statistics.

Female employment share

The share of female employment is taken from the European Labour Force Statistics (LFS) available at Eurostat. Missing data have been imputed using the EU average of the female employment rate at the corresponding industry level adjusted for the ratio between the respective country's female employment share for the entire manufacturing sector and the EU-wide female employment share for the entire manufacturing sector.

Firm exit and entry rates (churning)

The information on the exit and entry rates of firms into and out of an industry are taken from Eurostat's Business Demographics. The firm exit rate, labelled 'Death rate' in Eurostat, is defined as the number of enterprises exiting the industry at year *t* divided by the number of enterprises active in the preceding year.

Likewise, the entry rate, labelled 'Birth rate' in Eurostat, is defined as the number of enterprises entering the industry at year *t* divided by the number of enterprises active in the preceding year. Business churning is then simply the sum of the entry (birth) rate and the exit (death) rate. We impute missing values with the growth rates of manufacturing-level trends for the same country where available, and with the EU-wide trend if country-level data are missing altogether.

Unionisation rate

The information on the unionisation rate – or union density – is taken from the Data Base on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts, 1960–2017 (ICTWSS; Visser, 2019). The ICTWSS dataset is maintained jointly by the OECD and the Amsterdam Institute for Advanced Labour Studies (AIAS). From this dataset we use the union density variable, which is defined as the proportion of employees who are members of a trade union in their main job among all employees.

More precisely, we use the 'historical' series of the union density variable, which combines administrative and survey data and describes the historical trend in trade union density developments.

Outward-to-inward FDI ratio

The outward-to-inward FDI ratio is calculated on the basis of FDI stocks. The data are taken from UNCTAD's FDI database as published in the World Investment Report.[29] The few missing entries in the dataset could be filled with interpolations.

Table 1 gives an overview of the dependent variables – wages and working conditions – and the explanatory factors, together with the expected effect and the data sources. While the effect for several explanatory variables is a priori ambiguous – including the GVC integration measures – we have clear expectations regarding the effects of the functional specialisation measures that are in line with our hypotheses.

29 The data are available at https://unctadstat.unctad.org/wds (Accessed 13 April 2023).

Table 1: Variables, data sources and expected effects on wages and working conditions

Variable	Expected effect on		Source
	wages	working conditions	
Dependent variables			
Real wages			Eurostat (SBS); OECD ICIO database
Physical environment			European Working Conditions Survey
Work intensity			European Working Conditions Survey
Working time quality			European Working Conditions Survey
Social environment			European Working Conditions Survey
Skills and discretion			European Working Conditions Survey
Prospects			European Working Conditions Survey
Explanatory variables			
Functional specialisation measures			
Trade-based RFS in fabrication	−		WIOD Release 2016
Trade-based RFS in R&D	+		WIOD Release 2016
Trade-based factory-HQ ratio	−		WIOD Release 2016
FDI-based RFS in fabrication	−	±	fDi Markets cross border investment monitor
FDI-based RFS in R&D	+	+	fDi Markets cross border investment monitor
FDI-based factory-HQ ratio	−		fDi Markets cross border investment monitor

GVC participation measures			
Backward GVC participation rate	±	±	OECD ICIO database
Forward GVC participation rate	±	±	OECD ICIO database
Supply-side factors			
Real labour productivity	+	±	Eurostat (SBS); OECD ICIO database
Human capital index	+		PWT 10.0
Ratio high-to-low-skilled labour	±		WIOD Release 2013; Eurostat
Demand-side factors			
Long-term unemployment rate	−	−	Eurostat (unemployment statistics)
Vacancy rates	−	+	Eurostat (LFS)
Industry-level employment	+	+	Eurostat (SBS); OECD ICIO database
Share of female employment	−		Eurostat (LFS)
Enterprise churning (exit + entry rates)	±	±	Eurostat (business demographics)
Labour market institutions			
Union density	+	+	ICTWSS dataset
Worker characteristics			
Gender		±	European Working Conditions Survey
Immigrant		±	European Working Conditions Survey
Age		±	European Working Conditions Survey
Occupation		+	European Working Conditions Survey
Firm characteristics			
Size		±	European Working Conditions Survey
Ownership		±	European Working Conditions Survey

Note: '+' indicates an assumed positive relationship; '−' indicates an assumed negative relationship; '±' indicates an a priori ambiguous effect.

We also provide an overview of the correlation between wages (in log form) and all the explanatory variables as well as among all the explanatory variables (Table 2). This serves two purposes. First, it may hint at the relationship between the dependent variable (e.g. wages) and the explanatory factors. For example, both the trade-based and the FDI-based RFS in fabrication are negatively correlated with wages.

The same is true for the factory-headquarter measures. In contrast, the RFS in R&D is positively correlated with wages. The correlation matrix also confirms the very tight relationship between wages and real productivities (0.93). This means that labour productivity is expected to be a major determinant of wages, which makes it harder for other regressors to help explaining remaining variations in the wage level.

The second reason for checking the correlations is to avoid multicollinearity between any of the explanatory variables. Given the obtained correlations, any multicollinearity can be ruled out. One of the highest correlations is that between the outward-to-inward FDI ratio and the FDI-based RFS measures, but even here the correlation does not exceed 0.5 (the highest value is 0.46, found for the correlation between wages and the factory-headquarter measures).

Table 2: Correlations between variables

	ln wage	FDI-based RFS fabrication	FDI-based RFS R&D	FDI-based factory-HQ ratio	Trade-based RFS fabrication	Trade-based RFS R&D	Trade-based Factory-HQ ratio	ln labour productivity	Backward GVC participation	Forward GVC participation	ln human capital	High-to-low-skilled labour	Unionisation rate	Vacancy rate	Long-term unemployment	ln Employment	Manufacturing share	Female employ-ment share	Enterprise churning	Outward-to-inward-FDI ratio
ln wage	1.0000																			
FDI-based RFS fabrication	−0.2417*	1.0000																		
FDI-based RFS R&D	0.3444*	−0.1260*	1.0000																	
FDI-based factory-HQ ratio	−0.3678*	0.6819*	−0.9050*	1.0000																
Trade-based RFS fabrication	−0.0289	0.3178*	0.0226	0.2542*	1.0000															
Trade-based RFS R&D	0.2147*	0.1676*	0.1696*	0.0774*	0.8454*	1.0000														
Trade-based factory-HQ ratio	−0.4218*	0.1654*	−0.2615*	0.2332*	0.0623*	−0.4541*	1.0000													
ln labour productivity	0.9297*	−0.1697*	0.2960*	−0.2340*	0.0334	0.2486*	−0.3902*	1.0000												
Backward GVC participation	−0.1773*	0.1702*	−0.1685*	0.2932*	−0.0254	−0.1224*	0.1894*	−0.1509*	1.0000											
Forward GVC participation	0.0991*	0.0317	0.0586*	−0.0808*	−0.0059	0.0228	−0.0655*	0.1010*	−0.0825*	1.0000										
ln human capital	0.1230*	0.0631*	0.1343*	0.0329	0.0663*	0.1684*	−0.1905*	0.0840*	0.0778*	0.1305*	1.0000									
High-to-low-skilled labour	0.0007	0.0887*	0.1013*	0.0377	−0.0718*	−0.0738*	0.0329	0.0033	0.1378*	0.0456*	0.4439*	1.0000								
Unionisation rate	0.4452*	−0.2351*	0.1481*	−0.3108*	−0.0117	0.1261*	−0.2519*	0.3886*	−0.1625*	0.0761*	0.0855*	−0.1628*	1.0000							
Vacancy rate	0.0316	−0.0122	0.0192	0.0436	−0.0319	−0.0132	−0.0105	0.0458*	−0.0319	0.1074*	0.3213*	0.1188*	−0.0402*	1.0000						
Long-term unemployment	−0.3599*	0.0261	−0.1341*	0.0904*	−0.0406	−0.1522*	0.1973*	−0.3376*	0.0117	−0.0794*	−0.2172*	−0.0526*	−0.2823*	−0.2866*	1.0000					
ln employment	0.1852*	0.1732*	0.1429*	0.0224	0.5472*	0.6278*	−0.2647*	0.1561*	−0.2415*	0.1659*	0.0565*	−0.2271*	−0.0280	0.0055	−0.1252*	1.0000				
Manufacturing share	−0.1131*	0.2215*	−0.0810*	0.1804*	0.2252*	0.1626*	0.0749*	−0.0560*	0.2602*	0.0513*	0.2316*	0.1652*	0.0792*	−0.0383*	−0.1502*	0.0313	1.0000			
Female employment share	−0.3661*	0.0537*	−0.0713*	0.1545*	0.0664*	0.0756*	−0.0485*	−0.2919*	−0.1203*	−0.3702*	−0.0009	0.0922*	−0.1345*	−0.0031	0.0407*	−0.1642*	0.1112*	1.0000		
Enterprise churning	−0.4820*	0.1414*	−0.0710*	0.1031*	0.0350	−0.0745*	0.1785*	−0.4549*	0.0307	−0.0637*	0.1307*	0.2785*	−0.2601*	0.0189	0.0342	−0.1401*	0.0336	0.3555*	1.0000	
Outward-to-inward-FDI ratio	0.8682*	−0.2959*	0.3373*	−0.4564*	−0.0633*	0.2032*	−0.4518*	0.7629*	−0.2751*	0.0447*	0.0340	−0.0842*	0.4388*	0.0024	−0.2966*	0.2770*	−0.2608*	−0.2841*	−0.4582*	1.0000

*Note: * indicates a statistically significant correlation at the 1% level.*

4. Results

4.1 Wages

We estimate and explore various specifications of our econometric model presented in Section 3. Several functional specialisation measures are analysed (jointly and separately), and we have to compare the FDI-based and the trade-based measures.

More precisely, results for the following models are presented: (A) a *base model,* which contains – apart from the functional specialisation measure – only real productivity as a control variable; (B) a *supply-side model,* which includes in addition the above-mentioned supply-side factors; (C) a model which we label institutional *labour institutions model,* as it features the labour union indictor as well as the labour demand variables; (D) a *structural model,* which contains further structural indicators of the industries and countries; and finally (E) a model that adds the *outward-to-inward FDI ratio* to the list of regressors.

As a reminder, the functional measures are the RFS in fabrication (specification 1); the RFS in R&D (specification 2); the joint inclusion of the RFS in fabrication and the RFS in R&D (specification 3); and the factory-to-headquarter ratio (specification 4).

Naturally, the results are discussed in the context of our hypotheses but also with reference to existing findings in the literature. We start with the ordinary-least-square (OLS) fixed effects models[30] (Table 3 and Table 4) and then proceed to the instrumental variable (IV) regressions.

In order to keep the number of specifications reported within limits, we report all functional specialisation measures only for the base model and our preferred specification, which is the structural model.

4.1.1 OLS results

Starting with the models featuring the FDI-based RFS, the key result is certainly the negative sign of the coefficient for the RFS in fabrication and the positive coefficient of the RFS in R&D. This result is robust across all models and holds, irrespective of whether the RFS enter the regression separately (e.g. specification A1 and A2), jointly (specification A3) or in the form of the combined factory-HQ ratio (specification A4).

30 We also estimated all models and specifications in a pooled panel model. The results are available on request.

This pattern is fully in line with hypothesis 1a, which states that the effects of relative functional specialisation in fabrication on wages is quantitatively different from that of relative functional specialisation in R&D, but also hypothesis 1b. The latter is more demanding, as it calls not only for *qualitatively different* effects but also for *opposite* effects. That the effects go in opposite directions is of course most easily discernible in specification A3, where both the RFS in fabrication and the positive coefficient of the RFS in R&D are jointly included.

We postpone the discussion of hypothesis 2 to the IV regressions and for the moment take comfort from the fact that the coefficients of all the functional specialisation measures are fully robust across all four models, even if the estimates become somewhat less precise with the inclusion of further control variables.

Before going deeper into the details of the interpretation of the results for the functional specialisation measures, it is worth taking a look at the control variables.

A primary determinant of the wage level is certainly labour productivity, which turns out to be highly statistically significant and also economically important: in the base model with both the RFS in fabrication and RFS in R&D included (specification A3), a 10% increase in labour productivity would lead to a 3.9% higher wage. Important as it is, the size of the coefficient indicates also that there is no one-to-one relationship between wages and productivity (as predicted by the marginal productivity theory) and leaves ample room for additional explanatory factors. One of these additional factors is the extent of GVC integration (specification B).

It turns out that both the backward GVC participation measure (containing foreign value added) and the forward GVC participation measure (containing domestic value added) tends to hold wages back, ceteris paribus. The everything else being equal interpretation is crucial here, as labour productivity is controlled for separately. Hence, GVC integration may lead to higher productivity (Kummritz, 2016), which in turn affects wages positively.

Hence, what our results indicate is that GVC integration holds back wages, compared with a hypothetical situation in which domestic developments lead to similar productivity developments. This makes sense, because import competition – implicitly reflected in the backward GVC participation and typically associated with offshoring – and the continued need to improve international competitiveness – implicitly reflected in the forward GVC participation – tend to put downward pressure on wages (Bottini et al., 2007).

These effects can be locally concentrated (Autor et al., 2013; Autor et al., 2015), and were shown to be different across labour types, giving rise to job polarisation in Europe (Goos et al., 2009) and at the country level (see Koerner, 2022, for Germany).

Turning to the human capital variables (specifications B), we find – in line with our expectations – that the human capital stock at the country level as well as the ratio of high-skilled to-low skilled workers at the country-industry level are positively associated with wages. This finding is in line with the literature, including the positive effect of the share of university-educated workers in the US in McCausland et al. (2020). It should be noted, though, that the result for the high-skilled to low-skilled worker ratio is statistically significant only in some selected specifications and ceases to be significant in the more complete specifications.

In a next step, proxies for labour demand are added (specifications C). Here we find that the long-term unemployment rate (a country-level measure) has a negative effect on wages, while the coefficient of the job vacancy rate is not statistically significant. A surprise is the negative coefficient of the unionisation rate (which is available only at the country level). This goes against prior expectations, as union representation improves the bargaining position of workers.

However, this result is also found in McCausland et al. (2020). These authors argue that the negative relationship between wages and higher union coverage may reflect reverse causality, meaning that in countries with comparatively high wages workers may see less need to join a union and to have union representation. The same is true for union membership within a country over time.

While this could in principle explain the result for the unionisation rate, we believe that by using lagged values of the explanatory variables and by including the outward-to-inward FDI ratio (in specifications E), which can also be considered as a proxy for the stage of development, plus the control for labour productivity, we strongly reduce the likelihood of reverse causality of the type proposed in McCausland et al. (2020). Therefore, the negative coefficient of the unionisation rate remains somewhat puzzling, and the explanation may be more complex.

Magda et al. (2016), for example, found a wage premium from unionisation for the Czech Republic, Hungary and Poland, but also that this premium increased in the years after EU accession, which was a period of declining union coverage. However, due to institutional reforms in the labour market the strength of the unions increased despite falling membership numbers. This would mean that the unionisation rate may be too crude a proxy for the bargaining strength of unions.

The structural model in Table 3 is what may be called the full model (specifications D). It features a number of further interesting explanatory factors, which we would also like to explore.

Table 3: OLS panel fixed effects regression results, FDI-based functional specialisation and wages, 2003–2019

	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	(A2)	(A3)	(A4)	(B3)	(B4)	(C3)	(C4)	(D1)	(D2)	(D3)	(D4)	(E3)	(E4)
Functional measures														
RFS fabrication	−0.0397*** (0.0099)		−0.0428*** (0.0142)		−0.0300** (0.0151)		−0.0285* (0.0154)		−0.0272*** (0.0105)		−0.0238 (0.0153)		−0.0234 (0.0153)	
RFS R&D		0.0272*** (0.0065)	0.0243*** (0.0069)		0.0224*** (0.0069)		0.0248*** (0.0070)			0.0272*** (0.0067)	0.0257*** (0.0071)		0.0256*** (0.0071)	
RFS factory-HQ ratio				−0.0450*** (0.0095)		−0.0342*** (0.0097)		−0.0374*** (0.0099)				−0.0315*** (0.0095)		−0.0306*** (0.0095)
Labour productivity														
Labour productivity	0.3944*** (0.0281)	0.3795*** (0.0327)	0.3868*** (0.0345)	0.3831*** (0.0446)	0.3805*** (0.0338)	0.3774*** (0.0433)	0.3786*** (0.0346)	0.3834*** (0.0441)	0.3728*** (0.0296)	0.3558*** (0.0351)	0.3613*** (0.0373)	0.3534*** (0.0505)	0.3614*** (0.0373)	0.3503*** (0.0508)
GVC integration														
Backward GVC participation					−0.3263*** (0.0890)	−0.3701*** (0.1168)	−0.3485*** (0.0899)	−0.3911*** (0.1186)	−0.2655*** (0.0750)	−0.3253*** (0.0848)	−0.3559*** (0.0891)	−0.4141*** (0.1150)	−0.3641*** (0.0895)	−0.4286*** (0.1144)
Forward GVC participation					−0.2621 (0.1683)	−0.3466* (0.1966)	−0.3066* (0.1664)	−0.3921** (0.1957)	−0.2759** (0.1214)	−0.2861* (0.1595)	−0.3527** (0.1680)	−0.4664** (0.1979)	−0.3593** (0.1675)	−0.4664** (0.1960)
Supply-side factors														
Human capital index					0.6306** (0.2472)	0.6301** (0.3134)	0.8356*** (0.2661)	1.1006*** (0.3686)	0.6055*** (0.2115)	0.8489*** (0.2606)	0.8550*** (0.2634)	1.0103*** (0.3565)	0.9913*** (0.2634)	1.1730*** (0.3558)
High-low skilled labour ratio					0.0238 (0.0173)	0.0444** (0.0209)	0.0146 (0.0177)	0.0340 (0.0211)	−0.0008 (0.0126)	0.0055 (0.0174)	0.0027 (0.0176)	0.0184 (0.0193)	−0.0074 (0.0173)	0.0066 (0.0190)
Labour market and structural features														
Unionisation rate							−0.7766*** (0.2098)	−0.9488*** (0.2724)	−0.1940 (0.1529)	−0.6751*** (0.1952)	−0.6471*** (0.1980)	−0.7337*** (0.2608)	−0.7919*** (0.2056)	−0.9164*** (0.2693)
Job vacancy rate							0.2804 (0.7530)	1.5636* (0.8450)	−0.1312 (0.5917)	0.6313 (0.7354)	0.4223 (0.7554)	1.4923* (0.8532)	0.3037 (0.7482)	1.1179 (0.8405)
Long-term unemployment							−0.9192*** (0.1995)	−0.8527*** (0.2623)	−1.1152*** (0.1485)	−0.9313*** (0.1818)	−0.8736*** (0.1935)	−0.6792*** (0.2584)	−0.8526*** (0.1932)	−0.6151** (0.2599)
Employment (log)									0.0034 (0.0070)	0.0072 (0.0090)	0.0066 (0.0098)	0.0128 (0.0147)	0.0065 (0.0098)	0.0128 (0.0147)
Share of manufacturing									0.0105*** (0.0038)	0.0125*** (0.0041)	0.0125*** (0.0041)	0.0130*** (0.0048)	0.0116*** (0.0042)	0.0124** (0.0048)

	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	(A2)	(A3)	(A4)	(B3)	(B4)	(C3)	(C4)	(D1)	(D2)	(D3)	(D4)	(E3)	(E4)
Female employment share									−0.2020*** (0.0561)	−0.2059*** (0.0743)	−0.2088*** (0.0761)	−0.2825*** (0.0911)	−0.2091*** (0.0758)	−0.2844*** (0.0904)
Churning (enterprises)									−0.0001 (0.0009)	−0.0033*** (0.0013)	−0.0032** (0.0013)	−0.0025 (0.0018)	−0.0031** (0.0013)	−0.0025 (0.0018)
Outward-to-inward FDI ratio														
FDI ratio													0.1893*** (0.0497)	0.2306*** (0.0641)
Constant	5.7254*** (0.3006)	6.0003*** (0.3575)	5.9113*** (0.3767)	5.9988*** (0.4920)	5.3578*** (0.5052)	5.4302*** (0.6475)	5.4000*** (0.4983)	5.0983*** (0.6829)	5.3081*** (0.4121)	5.4252*** (0.4865)	5.3645*** (0.4986)	5.2644*** (0.6806)	5.3253*** (0.4961)	5.2397*** (0.6802)
Observations	3,720	2,914	2,843	2,165	2,843	2,165	2,685	2,019	3,561	2,756	2,685	2,019	2,685	2,019
R-squared	0.9542	0.9421	0.9426	0.9380	0.9433	0.9389	0.9467	0.9437	0.9573	0.9473	0.9478	0.9450	0.9481	0.9455
r2	0.954	0.942	0.943	0.938	0.943	0.939	0.947	0.944	0.957	0.947	0.948	0.945	0.948	0.945
R-sq. Adj.	0.954	0.941	0.942	0.937	0.942	0.937	0.946	0.942	0.957	0.946	0.947	0.943	0.947	0.944
F-value	115.0	93.77	63.14	44.47	30.19	16.21	35.15	14.95	49.51	36.71	35.13	22.50	37.45	24.29
F-test for equality of coefficients														
(RFS fabrication = RFS R&D)			21.02		11.37		11.38				9.9		9.78	
Prob > F			0.0000		0.0008		0.0008				0.0017		0.0018	

Notes: All explanatory variables enter the regressions with a 1-period lag. All regressions include country, industry and year fixed effects.
****, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses.*
All regressions estimated with STATA using the reghdfe command.

First, we find support for the claim of a 'manufacturing imperative' as a progressive sector which allows for paying higher wages (controlling for human capital and other factors) in the form of a positive and statistically significant coefficient of the employment share of the manufacturing sector. While well documented in the literature and cited inter alia also in McCausland et al. (2020), the most striking feature of the structural model is the strong negative effect of the share of female employment on wages.

Taking again the specification with both RFS measures included (specification D3), the coefficient of female employment suggests that a 1 percentage point higher share in female employment is associated with a 19% ($= e^{-0.2088} - 1$) lower wage for the average industry and country.[31] The finding that industries with higher female work participation pay significantly lower wages when controlling for labour demand, human capital and industry-fixed effects is at least consistent with the notion of wage discrimination of females in European labour markets.[32]

As a last structural characteristic to be discussed we find that the churning rate of enterprises in the manufacturing sector is associated with lower wages, although this effect is not robust across specifications.

Finally, we would like to discuss briefly the outward-to-inward FDI ratio taken on board in the final set of results (specification E). As expected, this FDI ratio (at the country level) is positively related to wages, and the coefficient is highly significant. Note that the FDI ratio serves primarily as a check on whether the functional specialisation is essentially captured by the relative engagement of countries in foreign direct investments. Much more than exports, outward FDI is concentrated in a few countries – those that are the home of a large number of MNEs.

Hence, the outward-to-inward FDI ratio is positively related to the RFS in R&D but negatively related to functional specialisation in fabrication. These relationships are strong, despite the fact that our RFS measures are based on inward FDI only. In our regression model, however, this FDI ratio leaves untouched the differentiated effects found for the functional specialisations as well as the negative effect of the factory-HQ ratio. Since the FDI ratio contains similar information as the RFS measures, our preferred specification is the structural model. In fact, the FDI ratio is likely to be a 'bad control' that opens up backdoor biases (Cinelli et al., 2022) in our model specification.

31 The magnitude of our coefficients for female employment is somewhat smaller but still comparable to those in McCausland et al. (2020) only in that they use the male employment share so that they obtain a positive coefficient.

32 The female wage gap is also documented in Gannon et al. (2007) for six European countries at the individual and firm level.

We should also mention that the coefficient of the RFS in fabrication is no longer statistically significant in the structural model (specification D3). However, the combined measure, i.e. the factory-HQ ratio (specification 4) is still negative and statistically highly significant, which shows that a high specialisation as a factory economy (high RFS in the factory-HQ ratio) relative to the specialisation as a headquarter economy (low RFS in the factory-HQ ratio) holds back wages.

This finding is confirmed by a Wald test for the equality of the coefficients of the RFS in fabrication and the RFS in the R&D in specification 3 in each of the models. For example, in the structural model the Wald test yields an F-value of 9.9, so that the null hypothesis of the equality of coefficients is rejected even at the 1% level (specification D.3).

Hence, while the structural model does not provide a statistical significance for the negative effect of the RFS in fabrication, there is still full support for a differentiated effect of the RFS measures (hypothesis 1a). In other words: functional specialisation matters for real wages. We should be very precise in interpreting this differentiated effect on wages, though. Since we control for many additional factors, including real labour productivity, what the results in Table 3 tell us is that wages are lower in countries that specialise functionally in fabrication than in countries that are not functionally specialised.

Similar to the reasoning for the GVC participation measures, we would interpret the absence of functional specialisation as a hypothetical scenario in which a country does not integrate into global value chains. Therefore, what we can say is that wages tend to be lower when countries specialise in fabrication compared with a hypothetical situation in which countries that do not specialise functionally but experienced the observed productivity developments. Likewise, wages tend to be higher when countries specialise in R&D, compared with a hypothetical situation in which countries do not specialise functionally, controlling for productivity developments.

The strong support for hypothesis 1 found in the FDI-based RFS measures, however, is not confirmed in the trade-based RFS measures (Table 4). In a model that controls for country-, industry- and year-fixed effects the trade-based measures do not capture any effects on wages, irrespective of whether a parsimonious model (e.g. the base model) or a very rich model (e.g. the structural model) is considered and irrespective of which functional specialisation measure is considered.

Hence, the country-year, industry-year and country-industry variation in the trade-based RFS measures are supposedly not systematically related (or at least not linearly related) to wages. The remainder of the regressors in the various models shown in Table 4 leads to the same results as in the FDI-based models.

Table 4: OLS panel fixed effects regression results, trade-based functional specialisation and wages, 2000–2014

	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	**(A2)**	**(A3)**	**(A4)**	**(B3)**	**(B4)**	**(C3)**	**(C4)**	**(D1)**	**(D2)**	**(D3)**	**(D4)**	**(E3)**	**(E4)**
Functional measures														
RFS fabrication	−0.0179 (0.0123)		−0.0043 (0.0213)		0.0092 (0.0214)		−0.0018 (0.0218)		−0.0188 (0.0227)		−0.0061 (0.0229)		−0.0032 (0.0230)	
RFS R&D		−0.0186 (0.0136)	−0.0150 (0.0248)		−0.0261 (0.0243)		−0.0107 (0.0250)			−0.0198 (0.0237)	−0.0157 (0.0271)		−0.0175 (0.0270)	
RFS factory-HQ ratio				0.0078 (0.0210)		0.0154 (0.0208)		−0.0018 (0.0214)				0.0001 (0.0212)		0.0021 (0.0212)
Labour productivity														
Labour productivity	0.3667*** (0.0243)	0.3676*** (0.0249)	0.3676*** (0.0249)	0.3635*** (0.0238)	0.3622*** (0.0250)	0.3585*** (0.0238)	0.3442*** (0.0262)	0.3407*** (0.0249)	0.3328*** (0.0252)	0.3338*** (0.0262)	0.3339*** (0.0261)	0.3302*** (0.0249)	0.3337*** (0.0260)	0.3303*** (0.0247)
GVC integration														
Backward GVC participation					−0.1374** (0.0551)	−0.1468*** (0.0554)	−0.1517*** (0.0542)	−0.1574*** (0.0544)	−0.1166** (0.0526)	−0.1198** (0.0521)	−0.1183** (0.0527)	−0.1237** (0.0524)	−0.1243** (0.0529)	−0.1293** (0.0527)
Forward GVC participation					−0.2674** (0.1073)	−0.2493** (0.1048)	−0.2706** (0.1053)	−0.2576** (0.1033)	−0.2845*** (0.1051)	−0.2850*** (0.1047)	−0.2864*** (0.1052)	−0.2725*** (0.1041)	−0.2977*** (0.1057)	−0.2846*** (0.1046)
Supply-side factors														
Human capital index					0.3308 (0.2278)	0.3074 (0.2268)	0.4904** (0.2422)	0.4706* (0.2415)	0.4695** (0.2386)	0.4754** (0.2390)	0.4752** (0.2390)	0.4604* (0.2380)	0.5390** (0.2398)	0.5250** (0.2388)
High-low skilled labour ratio					0.0541*** (0.0119)	0.0547*** (0.0116)	0.0433*** (0.0117)	0.0436*** (0.0114)	0.0413*** (0.0119)	0.0421*** (0.0117)	0.0418*** (0.0117)	0.0421*** (0.0115)	0.0347*** (0.0113)	0.0350*** (0.0112)
Structural features														
Unionisation rate							−0.4669*** (0.1186)	−0.4783*** (0.1173)	−0.4848*** (0.1175)	−0.4715*** (0.1186)	−0.4744*** (0.1188)	−0.4838*** (0.1177)	−0.5209*** (0.1223)	−0.5302*** (0.1211)
Job vacancy rate							2.7882*** (0.8277)	2.8090*** (0.8242)	3.0909*** (0.8273)	3.1023*** (0.8259)	3.0993*** (0.8269)	3.0959*** (0.8275)	3.3494*** (0.8373)	3.3447*** (0.8375)
Long-term unemployment							−1.0994*** (0.1499)	−1.1076*** (0.1502)	−1.0849*** (0.1472)	−1.0760*** (0.1515)	−1.0754*** (0.1513)	−1.1051*** (0.1476)	−1.1923*** (0.1481)	−1.2206*** (0.1441)
Employment (log)									0.0098 (0.0107)	0.0101 (0.0108)	0.0109 (0.0115)	0.0029 (0.0065)	0.0105 (0.0115)	0.0030 (0.0064)
Value-added share of manufacturing									−0.0004 (0.0026)	−0.0005 (0.0026)	−0.0004 (0.0026)	−0.0004 (0.0026)	−0.0017 (0.0027)	−0.0017 (0.0027)

	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	**(A2)**	**(A3)**	**(A4)**	**(B3)**	**(B4)**	**(C3)**	**(C4)**	**(D1)**	**(D2)**	**(D3)**	**(D4)**	**(E3)**	**(E4)**
Female employment share									−0.3077*** (0.0569)	−0.3085*** (0.0568)	−0.3086*** (0.0568)	−0.3058*** (0.0571)	−0.3090*** (0.0563)	−0.3064*** (0.0566)
Churning (enterprises)									−0.0008 (0.0007)	−0.0008 (0.0007)	−0.0008 (0.0007)	−0.0008 (0.0007)	−0.0008 (0.0007)	−0.0008 (0.0007)
Outward-to-inward FDI ratio														
FDI ratio													0.1166*** (0.0341)	0.1170*** (0.0341)
Constant	5.9811*** (0.2600)	5.9719*** (0.2668)	5.9718*** (0.2667)	6.0183*** (0.2540)	5.6732*** (0.3862)	5.7424*** (0.3693)	5.8321*** (0.4231)	5.8984*** (0.4042)	5.9956*** (0.4359)	5.9713*** (0.4585)	5.9630*** (0.4586)	6.1071*** (0.3998)	5.9833*** (0.4581)	6.1196*** (0.4001)
Observations	3,748	3,748	3,748	3,748	3,748	3,748	3,598	3,598	3,598	3,598	3,598	3,598	3,598	3,598
R-squared	0.9612	0.9612	0.9612	0.9612	0.9617	0.9617	0.9619	0.9619	0.9626	0.9626	0.9626	0.9625	0.9627	0.9627
r2	0.961	0.961	0.961	0.961	0.962	0.962	0.962	0.962	0.963	0.963	0.963	0.963	0.963	0.963
R-sq. Adj.	0.961	0.961	0.961	0.961	0.961	0.961	0.961	0.961	0.962	0.962	0.962	0.962	0.962	0.962
F-value	128.9	137.1	94.46	128.9	55.36	62.46	86.36	95.14	67.99	69.29	65.18	68.76	61.61	64.69
F-test for equality of coefficients														
(RFS fabrication = RFS R&D)			0.0600		0.6500		0.0400				0.0500		0.1100	
Prob > F			0.8097		0.4186		0.8437				0.8248		0.7396	

Notes: All explanatory variables enter the regressions with a 1-period lag. All regressions include country, industry and year fixed effects.
***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses.*
All regressions estimated with STATA using the reghdfe command.

A priori, we had expected stronger effects in the trade-based RFS measures compared with the FDI-based RFS measures because the former are based on labour compensation at the level of occupations across industries and countries. We do find large and significant effects of the trade-based RFS measures, but only in a pooled version of our wage regression model. However, all joint F-tests for the relevance of country-, industry- and year-effects[33] decide in favour of including these fixed effects. We report the OLS results in the Appendix for the sake of completeness while refraining from drawing any conclusions from these results.

4.1.2 Instrumental variable results

We now return to hypothesis 2, which stipulates a causal relationship running from functional specialisation to wages and working conditions. To argue for such a causal relationship, we use the IV strategy outlined in Section 3, which rests on the RFS of out-of-sample countries at the industry level that are closely related to the respective country in the sample. The tests for the validity of the instrumental variables are reported in the Appendix, along with the results from the first stage regressions.

The results of the IV fixed-effects specification are reported in Table 5. A first comforting observations is that instrumenting for the RFS measures does not qualitatively affect any of the control variables. The coefficients of all explanatory factors maintain their sign compared with the corresponding OLS fixed-effects model (see Table 3), including labour productivity, the GVC participation measures, the long-term unemployment rate and the female employment share.

We do see some changes in the results for the RFS measures compared with the OLS fixed-effects model. Since the changes are consistent across all models, we focus on the structural model (specifications D). The most interesting aspect is that the RFS in fabrication is statistically significant at the 1% level. Hence, it is estimated more precisely than in the OLS model. In contrast, the coefficient of the RFS in R&D is statistically no longer significant.

33 We ran these F-tests subsequently, first for all country-fixed effects, followed by industry-fixed effects and finally all year-fixed effects.

Table 5: Instrumental variables regressions, fixed effects, FDI-based functional specialisation and wages, 2003–2019

	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	**(A2)**	**(A3)**	**(A4)**	**(B3)**	**(B4)**	**(C3)**	**(C4)**	**(D1)**	**(D2)**	**(D3)**	**(D4)**	**(E3)**	**(E4)**
Functional measures														
RFS fabrication	−0.1172*** (0.0247)		−0.1136*** (0.0339)		−0.1002*** (0.0346)		−0.0929*** (0.0338)		−0.1115*** (0.0253)		−0.0926*** (0.0350)		−0.0964*** (0.0349)	
RFS R&D		0.0061 (0.0105)	−0.0000 (0.0113)		0.0023 (0.0113)		0.0044 (0.0111)			0.0115 (0.0102)	0.0061 (0.0112)		0.0056 (0.0112)	
RFS factory-HQ ratio				−0.0581* (0.0346)		−0.0500 (0.0350)		−0.0669* (0.0361)				−0.0547 (0.0380)		−0.0559 (0.0378)
Labour productivity														
Labour productivity	0.4005*** (0.0097)	0.3801*** (0.0109)	0.3937*** (0.0117)	0.3856*** (0.0150)	0.3881*** (0.0119)	0.3807*** (0.0153)	0.3858*** (0.0120)	0.3897*** (0.0156)	0.3778*** (0.0100)	0.3557*** (0.0114)	0.3661*** (0.0122)	0.3576*** (0.0162)	0.3665*** (0.0122)	0.3548*** (0.0162)
GVC integration														
Backward GVC participation					−0.2857*** (0.0723)	−0.3465*** (0.0966)	−0.3103*** (0.0725)	−0.3475*** (0.0974)	−0.2138*** (0.0578)	−0.3274*** (0.0671)	−0.3150*** (0.0723)	−0.3834*** (0.0960)	−0.3207*** (0.0722)	−0.3951*** (0.0959)
Forward GVC participation					−0.2329 (0.1458)	−0.3365* (0.1785)	−0.2787* (0.1450)	−0.3696** (0.1782)	−0.2177** (0.1090)	−0.2776** (0.1390)	−0.3059** (0.1455)	−0.4429** (0.1792)	−0.3099** (0.1452)	−0.4410** (0.1786)
Supply-side factors														
Human capital index					0.6745* (0.3642)	0.6319 (0.4472)	0.8819** (0.3905)	1.1016** (0.4878)	0.6124** (0.2950)	0.8970** (0.3845)	0.8813** (0.3874)	1.0011** (0.4835)	1.0161*** (0.3881)	1.1609** (0.4838)
High-low skilled labour ratio					0.0210** (0.0102)	0.0432*** (0.0138)	0.0124 (0.0101)	0.0315** (0.0140)	−0.0040 (0.0079)	0.0067 (0.0100)	0.0006 (0.0102)	0.0173 (0.0141)	−0.0097 (0.0105)	0.0056 (0.0143)
Labour market and structural features														
Unionisation rate							−0.7670*** (0.2064)	−0.9886*** (0.2755)	−0.2245 (0.1631)	−0.6495*** (0.2034)	−0.6386*** (0.2062)	−0.7757*** (0.2792)	−0.7834*** (0.2090)	−0.9596*** (0.2814)
Job vacancy rate							0.3266 (0.8611)	1.5776 (1.0361)	0.0339 (0.6839)	0.6296 (0.8263)	0.4768 (0.8537)	1.5090 (1.0249)	0.3623 (0.8523)	1.1409 (1.0263)
Long-term unemployment							−0.8938*** (0.2271)	−0.8471*** (0.2918)	−1.0699*** (0.1740)	−0.9408*** (0.2104)	−0.8343*** (0.2261)	−0.6688** (0.2910)	−0.8107*** (0.2257)	−0.6047** (0.2904)
Employment (log)									0.0127** (0.0058)	0.0073 (0.0062)	0.0130* (0.0072)	0.0155* (0.0091)	0.0132* (0.0072)	0.0158* (0.0090)
Value-added share of manufacturing									0.0102*** (0.0018)	0.0125*** (0.0021)	0.0124*** (0.0021)	0.0126*** (0.0025)	0.0115*** (0.0021)	0.0120*** (0.0025)

	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	(A2)	(A3)	(A4)	(B3)	(B4)	(C3)	(C4)	(D1)	(D2)	(D3)	(D4)	(E3)	(E4)
Female employment share									−0.1917*** (0.0408)	−0.2085*** (0.0521)	−0.1998*** (0.0536)	−0.2665*** (0.0705)	−0.1995*** (0.0535)	−0.2669*** (0.0703)
Churning (enterprises)									0.0001 (0.0010)	−0.0031** (0.0013)	−0.0025* (0.0013)	−0.0026* (0.0016)	−0.0024* (0.0013)	−0.0025 (0.0016)
Outward-to-inward FDI ratio														
FDI ratio													0.1884***	0.2275***
Observations	3,720	2,914	2,843	2,165	2,843	2,165	2,685	2,019	3,561	2,756	2,685	2,019	2,685	2,019
R-sq. Adj.	0.299	0.287	0.278	0.255	0.286	0.265	0.311	0.292	0.334	0.334	0.324	0.308	0.327	0.313
F-value	851.5	609.2	388.1	387.3	173.8	137.9	128.7	98.47	147.9	110.5	97.52	73.65	92.51	69.95
F-test for equality of coefficients														
(RFS fabrication = RFS R&D)			11.14		8.81		1.25				8.34		8.96	
Prob > F			0.0009		0.0030		0.2629				0.0039		0.0028	

Notes: All explanatory variables enter the regressions with a 1-period lag. All regressions include country, industry and year fixed effects.
****, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses.*
The instrument is the weighted average RFS of the five countries with the highest correlation of the RFS at the country-industry and over time.
All regressions estimated with STATA using the ivreghdfe command.

We interpret this as evidence of an upward bias in the OLS model for both RFS measures. This upward bias is grounded in the positive reverse causality from wages on functional specialisation. Hence, as before, the negative sign of the coefficient of the RFS in fabrication is to be interpreted as follows: functional specialisation as a factory economy holds back wages – ceteris paribus. If we accept interpreting the results of the IV regression as causal, then this lends support to hypothesis 2.

This holds true even if the estimate for the RFS in R&D is not statistically significant. Moreover, we have the effect of functional specialisation on wages for RFS in fabrication, and the F-test clearly rejects the null hypothesis that the effects of the RFS in fabrication and the RFS in R&D are identical.

We are now in a position to sum up the empirical results. We obtain confirmation for hypothesis 1a as well as a partial confirmation of hypothesis 1b (the part referring to an RFS in fabrication having a negative impact on wages) from the FDI-based RFS models. Moreover, for the RFS in fabrication hypothesis 2 was also confirmed.

From this we can draw an additional conclusion: there is a certain sensitivity of the results with regard to the choice of the functional specialisation measures. We put a certain degree of trust in the FDI-based indicators for at least three reasons.

The first reason is of a methodological nature. There is little doubt that FDI activities, and greenfield FDI in particular, are related to GVCs and functional specialisation, so that constructing corresponding measures from FDI data seems straightforward. Second, with regard to methodology, the FDI-based RFS measures are very transparent because they can be obtained directly from the information in the underlying dataset, even if it could be argued that this entails some risk of measurement error.[34]

Third, the results for the FDI-based RFS measure are consistent across all model specifications – pooled panel estimations, fixed-effect estimations and IV fixed-effect estimations. For these reasons we believe that our FDI-based results provide important empirical evidence for both hypotheses put forward.

34 Measurement error cannot be fully excluded, but we have a sufficiently high number of observations, so this should have no serious effect on the results.

4.2 Other non-wage working conditions

Similar to wages (see Section 4.1 above), we also estimated different models (A-D), but for the sake of brevity only present and discuss model D.[35] For a similar reason we only use the two functional specialisation measures jointly and, as outlined above, only focus on the FDI-based functional specialisation measures to make full use of the available data.

As outlined above, we differenced all non-EWCS-based indicators to allow for effects to take time to materialise and used three differencing periods – one year, two years and three years – capturing short-term and longer-term effects. Results for one-year differences are presented in Table 6 below (the correlation matrix between the key variables is provided in Table 14 in the Appendix), while those for three-year differences are reported in Table 15 in the Appendix.[36]

Our results for the two functional specialisation measures generally point to significant effects for some non-wage working conditions (see Table 6 below and Table 15 in the Appendix). This is consistent with hypothesis 2 on the causal effect of functional specialisation patterns on non-wage working conditions. However, effects are only observable for a few of the tested non-wage working conditions, but then for the same ones for both functional specialisation measures.

Specifically, an increase in the functional specialisation in fabrication and R&D leads to a better physical environment and lower work intensity for workers. The coefficients are strongly significant at the 1% and 5% level of statistical significance. For functional specialisation in fabrication, we also observe an improvement in workers' cognitive demands, decision latitude and organisational participation (captured by the working condition 'skills and discretion'), which is, however, only marginally significant. Nevertheless, in line with hypothesis 1a, the effects differ quantitatively, with a stronger effect for the functional specialisation measure in fabrication than for the functional specialisation measure in R&D.

Furthermore, in view of the generally positive (if only few) effects, our results are in line with the idea of competition-induced adaptive technology upgrading for the relative specialisation in fabrication and a further 'climb to the top' for the relative specialisation in R&D (see hypothesis 3).

35 The results for models A–C are available from the authors on request.
36 Results for two-year differences are available from the authors on request.

Table 6: Multilevel regression results: FDI-based functional specialisation and other working conditions, pooled sample for 2010 and 2015 (D1)

	(1) Physical environment	(2) Work intensity	(3) Worktime quality	(4) Social environment	(5) Skills & discretion	(6) Prospects
Functional measures						
D.RFS fabrication	−0.930*** (−2.655)	−0.922** (−2.141)	0.013 (0.034)	0.087 (0.295)	0.843* (1.707)	−0.202 (−0.516)
D.RFS R&D	−0.583*** (−2.645)	−0.385** (−2.299)	−0.287 (−1.337)	−0.050 (−0.684)	−0.036 (−0.203)	−0.001 (−0.003)
Worker characteristics						
Female (yes = 1)	−0.610*** (−6.499)	0.034 (0.481)	−0.327*** (−5.291)	0.034 (1.308)	−0.311*** (−6.473)	−0.177*** (−4.216)
Migrant (yes =1)	0.117 (1.325)	0.040 (0.463)	0.107** (2.019)	0.051 (1.560)	−0.220*** (−2.763)	−0.035 (−0.575)
15–24 years old	0.119 (1.132)	0.019 (0.197)	0.247** (2.498)	0.035 (0.800)	−0.357*** (−3.663)	0.559*** (5.696)
25–49 years old	0.032 (0.549)	0.057 (1.184)	0.128*** (3.435)	0.029 (1.501)	−0.040 (−0.857)	0.386*** (8.237)
ISCO-medium	−0.344*** (−3.516)	−0.215*** (−4.761)	−0.333*** (−5.630)	−0.024 (−1.241)	0.684*** (7.028)	0.271*** (4.881)
ISCO-high	−1.215*** (−13.247)	−0.320*** (−5.293)	−0.389*** (−5.447)	−0.064*** (−3.536)	1.783*** (18.726)	0.632*** (13.118)
Firm characteristics						
Firm size: medium	0.072 (1.166)	0.061 (0.800)	0.093 (1.451)	0.035 (1.331)	−0.270*** (−3.433)	−0.043 (−0.914)
Firm size: large	−0.009 (−0.135)	0.159* (1.951)	0.314*** (4.645)	0.021 (0.766)	−0.039 (−0.416)	0.027 (0.457)
Firm type: private	−0.055 (−0.352)	0.227** (2.001)	0.036 (0.289)	0.068* (1.696)	−0.149* (−1.679)	−0.133** (−1.976)
Firm type: other	0.083 (0.406)	0.419*** (3.380)	0.178 (1.573)	0.110 (1.107)	−0.074 (−0.436)	−0.172 (−0.949)
Supply-side factors						
D.labour productivity (ln)	−0.117 (−0.656)	0.273 (1.400)	−0.422*** (−3.305)	0.041 (0.404)	−0.002 (−0.009)	0.303* (1.865)
GVC integration						
D.backward GVC participation	1.158 (0.664)	1.285 (0.891)	−1.408 (−1.368)	1.031** (2.015)	−1.291 (−0.904)	1.569 (1.587)
D.forward GVC participation	1.203 (0.350)	1.760 (0.898)	−0.695 (−0.396)	0.152 (0.112)	1.396 (0.392)	0.302 (0.164)
Labour market and structural features						
D.unionisation rate	−4.147 (−1.210)	−3.841 (−0.999)	−4.177* (−1.685)	−0.246 (−0.191)	−3.338 (−0.789)	1.256 (0.412)
D.job vacancy rate	−16.254 (−0.822)	−6.604 (−0.346)	−17.354** (−2.265)	−10.404* (−1.773)	−23.799** (−2.545)	−9.625 (−0.854)
D.long-term unemployment	5.300 (1.305)	−7.949** (−2.063)	−5.474** (−1.969)	1.998 (1.205)	−1.540 (−0.624)	−3.890 (−1.249)
D.employment (ln)	0.265 (0.726)	0.039 (0.138)	0.648** (2.397)	0.014 (0.127)	0.031 (0.091)	0.001 (0.003)
D.value-added share of manufacturing	−0.026 (−0.929)	−0.028 (−1.096)	0.010 (0.579)	−0.004 (−0.439)	−0.018 (−0.764)	−0.038* (−1.671)

	(1) Physical environment	(2) Work intensity	(3) Worktime quality	(4) Social environment	(5) Skills & discretion	(6) Prospects
D.churning (enterprises)	0.010 (0.562)	0.006 (0.307)	−0.005 (−0.393)	−0.009 (−0.932)	−0.000 (−0.013)	0.011 (1.299)
Country characteristics						
D.real GDP per capita (ln)	2.083 (1.601)	−0.426 (−0.300)	0.082 (0.086)	0.681 (1.294)	−0.800 (−0.489)	0.203 (0.154)
Wave FE	0.087 (0.766)	−0.026 (−0.252)	−0.060 (−0.893)	0.046 (1.099)	0.030 (0.393)	0.239*** (2.853)
Constant	0.872*** (3.461)	0.110 (0.719)	0.097 (0.510)	−0.214*** (−2.821)	−0.480** (−2.554)	−0.510*** (−3.527)
Random effects						
Industry	0.106***	0.039***	0.067***	0.009*	0.031*	0.028**
Country	0.043*	0.071**	0.077**	0.003*	0.172***	0.044*
Observations	3,847	3,885	3,884	3,913	3,908	3,913
Number of groups	24	24	24	24	24	24

*Notes: ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses. Weights are used in estimations.*

As far as the remaining control variables are concerned, we observe interesting results. For instance, with regard to individual worker conditions, we find that while women tend to work under physically less demanding working conditions and hold jobs that are characterised by higher working-time quality, they also tend to hold cognitively less demanding and less attractive jobs with little decision latitude and organisational participation (captured by the working condition ‘skills & discretion’) and to have worse prospects (i.e. career prospects and job security) than men.

Traditional gender roles and the risk of (as well as actual) career interruptions help to explain their inferior position with regard to skills and prospects. Similarly, migrant workers are also disadvantaged in some respects: they tend to hold jobs that are characterised by significantly lower working-time quality and, similar to women, by lower skills and discretion. Workers’ age is also of importance, as younger workers tend to hold jobs with worse working-time quality, but better prospects compared with older workers (aged 50 and above). Furthermore, as expected, more highly skilled occupations are associated with better working conditions, regardless of the specific working condition considered.

Working conditions also differ across firms and tend to be better in smaller and public-sector firms. Specifically, workers employed in large firms hold jobs that are characterised by higher work intensity (but only at the 10% of statistical significance) as well as worse working-time quality than workers employed in small firms. Moreover, workers in medium-sized firms are disadvantaged with respect to skills and discretion.

Similarly, working conditions also differ by ownership structure, as workers employed in the private sector tend to hold worse jobs in terms of higher working-time quality, lower skills and discretion (only marginally significant), and prospects than those employed in the public sector. This is expected and in line with the related literature (Eurofound, 2017a).

Similar to wages (see Section 4.1 above), labour productivity is also an important determinant of other working conditions. Specifically, we find that an increase in labour productivity in the previous year is associated with better working conditions in the following year in terms of better working-time quality and prospects. However, longer-run changes tend to be associated with worse working conditions in terms of significantly higher work intensity (see Table 15) which, put together, suggests that an important driving force behind productivity improvements – technological upgrading – has different effects on working conditions, some of which are only felt in the longer run.

By contrast, we find only a little role for a change in either backward or forward GVC participation for other working conditions, at least in the short run. The only exception refers to workers' social environment, which tends to be significantly worse in the year following an increase in backward GVC participation. An increase in competitive pressures may be an important explanatory factor. However, more working conditions are adversely affected by longer-term changes in GVC participation (see Table 15).

In addition to the worse social environment, a longer-term increase in backward GVC participation is also associated with lower skills and discretion, while a longer-term increase in forward GVC participation is associated with a significantly worse physical working environment. The latter finding refutes the hypothesis that reputation-sensitive MNEs may put pressure on their suppliers to improve their working conditions.

As far as the remaining labour market and structural factors are concerned, we find, for instance, that an increase in the unionisation rate in the previous year is associated with better working-time quality (marginally significant) in the following year. Longer-term changes in the unionisation rate are also associated with a better social environment as well as better prospects. This is in contrast to what we found for wages and underscores the important role that stronger union representation and power plays for non-wage working conditions.

Furthermore, as expected, an increase in the industry-level vacancy rate in the previous year is associated with better working conditions in the year after in terms of better working-time quality and social environment. However, this positive association does not hold for all working conditions, as in the case of skills and discretion, which tend to be lower in the year following an increase in the vacancy rate.

Somewhat unexpectedly, we found that an increase in the long-term unemployment rate in the previous year is associated with better working conditions in terms of lower work intensity and better working-time quality. The expected negative effect due to a loss in bargaining power only shows in relation to longer-term increases in the vacancy rate that are associated with a worse social environment (marginally significant) and lower prospects.

A comparison of coefficients suggests that the effect for prospects is particularly pronounced and suggests that growing structural labour market issues over a longer period of time mainly materialise in workers' worse career prospects and job security (as captured by prospects). We find little evidence that growing industries – as captured by the number of employees – are characterised by better working conditions that may result from an improvement in workers' bargaining position.

Quite the contrary, some selective working conditions – working-time quality in the short run and skills and discretion in the longer run – are worse following an expansion of an industry. As concerns the share of manufacturing, only longer-term changes have any statistically significant, but nonetheless differentiated, effect: while the physical environment is better and work intensity is lower after a longer-term increase in the share of manufacturing, both working-time quality and skills and discretion are worse.

We also do not find any statistically significant results for a change in the churning rate. Finally, contrary to our expectations, we find that working conditions turn out to be worse following longer-term improvements in economies' GDP per capita (Table 15). Specifically, except for work intensity and working-time quality, all working conditions are worse in prospering economies.

5. Conclusions

The objective of this study was to examine the effects of functional specialisation enabled by GVC integration on wages and non-wage working conditions in EU countries. Using the dichotomy of 'factory' and 'headquarter' economies – confirmed in the EU context by Kordalska et al. (2022) – as a starting point for our analysis, we postulated that the different positions in which individual EU countries find themselves along manufacturing value chains are likely to have an impact on their ability to accrue economic rents, parts of which will be shared with workers in the form of higher wages.

While specialisation can be expected to bring about gains across the board from a Ricardian perspective, predominantly via the productivity channel, the overall effects are likely to vary at the functional level. This can be attributed to the heterogeneity in competitive forces dominating different functions.

Given the relative simplicity with which the necessary skills for carrying out fabrication activities can be acquired, specialisation in the fabrication function can be expected to be subject to the most intense competitive pressures, driven by the ease of substitution of one country by another in this particular segment of the value chain. In turn, one would expect the fabrication specialisation to act as a damper on wages and other working conditions, ceteris paribus.

Conversely, because the skills and endowments required for an economy to relatively specialise in R&D activities are of higher complexity, countries focused on the more sophisticated activities of the value chain would be exposed to competitive pressures to a far lesser extent.

Following the above reasoning, we tested three (inter-related) hypotheses regarding the relationship between functional specialisation on the one hand and wages and non-wage working conditions on the other hand. The first hypothesis we explored was the postulated differentiation across functions, driven by the differences in competitive pressures. In the wage regressions, we find this differentiation in both the FDI-based and the trade based functional specialisation, though statistical significance can only be claimed for the former.

Moreover, in a related hypothesis – which only concerns wages – we claimed that not only are the effects of functional specialisation in fabrication and R&D different, but more precisely that the former tends to hold back wage progression, while the latter has a positive effect on wages. With regard to non-wage working conditions, we found that both functional specialisation measures positively affect two out of the six working conditions analysed – the physical work environment and work intensity. Importantly, this effect is stronger for the specialisation in fabrication than in R&D.

Overall, we were able to demonstrate empirically the differentiated effects of functional specialisation in fabrication and in R&D on wages and on selected non-wage working conditions. Countries specialised as 'factory economies' tend to suffer from their functional specialisation in terms of a negative impact on wage progression, but other non-wage working conditions improve in form of a better physical environment and lower work intensity. Countries specialised as 'headquarter economies' benefit from their functional specialisation in the form of higher wages, but their benefits from improved other working conditions are lower.

Hence, our findings have particularly important implications for factory economies within EU value chains: it is these economies that are subject to a 'specialisation burden' in labour markets from the perspective of wages. Here, assuming the same labour market demand and supply conditions, including labour productivity levels, a set-up with no functional specialisation would be anticipated to translate into improvements in their wage levels.

In this way, our findings add further to the debate of various development traps faced by factory economies and shed light on some of the channels through which these challenges materialise. One implication of this result is that EU-CEE economies should scale up efforts to diversify their functional specialisation profile. Given the current specialisation of these countries in fabrication activities, this would imply a shift towards more knowledge- and skill-intensive segments of the value chain, resulting in functional upgrading.

Such an adjustment seems overdue in view of the inadequate functional specialisation of the EU-CEE countries given their income level (Stöllinger, 2019). Hence, functional diversification – without giving up fabrication activities but rather taking on new activities – would be a step towards increasing wages and avoiding a 'functional growth trap'.

Finally, the empirical methods employed allow us to give these results a causal interpretation. More specifically, our results suggest the existence of a causal relationship running from the functional specialisation of an economy to the working conditions in a country. This echoes the point raised in Kordalska et al. (2022) that the functional dimension to specialisation is particularly closely linked to the individual employees of any given country.

Given the amount of underexplored questions regarding the impacts of functional specialisation on overall economic conditions, there is ample scope for future research. For one, it would be interesting to compare the results of our study carried out in the EU context with a different geographical location where a factory-headquarter dichotomy can be identified, such as East and Southeast Asia. Likewise, the study could be expanded to explore the effects of functional specialisation on labour market conditions at the sub-national level.

This would allow to shed light on the role functional specialisation plays in regional disparities in wages and other labour conditions. Moreover, through our study we could only speculate as to why the FDI-based measure seemed to offer more explanatory power. Therefore, a study which would facilitate a better understanding of the differences in the effects that the two approaches to measuring relative functional specialisation have on labour market conditions would be highly informative.

6. Literature

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Appendix

A.1 Countries, industries and value-chain functions

The EU member states included in the sample are listed in Table 7.

The industry structure is identical for the regressions using trade-based and FDI-based RFS measures and is shown in Table 8.

Naturally, the definition of value-chain functions on which the RFS measures are based differ for the FDI-based and the trade-based measures. They are shown in Table 9 and Table 10, respectively.

Table 7: EU member states included in the sample

Country	**Country code**	**Eurostat country code**
Austria	AUT	AT
Belgium	BEL	BE
Bulgaria	BGR	BG
Czechia	CZE	CZ
Germany	DEU	DE
Denmark	DNK	DK
Spain	ESP	ES
Estonia	EST	EE
Finland	FIN	FI
France	FRA	FR
United Kingdom	GBR	UK
Greece	GRC	EL
Croatia	HRV	HR
Hungary	HUN	HU
Ireland	IRL	IE
Italy	ITA	IT
Lithuania	LTU	LT
Latvia	LVA	LV
Netherlands	NLD	NL
Poland	POL	PL
Portugal	PRT	PT
Romania	ROU	RO
Slovakia	SVK	SK
Slovenia	SVN	SI
Sweden	SWE	SE

Table 8: NACE Rev. 2 industry structure

Manufacture of	**NACE Rev. 2**
food and beverages; tobacco	10–12
textiles; wearing apparel; leather	13–15
chemicals	20
pharmaceuticals	21
minerals, metals and metal products	23–25
computer, electronic and optical products	26
electrical equipment	27
machinery and equipment	28
motor vehicles	29
other transport equipment	30

Table 9: Functional specialisation in FDI – Mapping of activities into functions

<table>
<tr><th>Activity
(in the fDi cross-border monitor)</th><th>Value-chain functions
(narrow categories)</th><th>Value-chain functions
(broad categories)</th></tr>
<tr><td>Research & development</td><td rowspan="2">R&D and related services</td><td rowspan="3">Pre-production</td></tr>
<tr><td>Design, development & testing</td></tr>
<tr><td>Headquarter</td><td>Headquarter services</td></tr>
<tr><td>Manufacturing</td><td rowspan="3">Production</td><td rowspan="3">Production</td></tr>
<tr><td>Recycling</td></tr>
<tr><td>Extraction*</td></tr>
<tr><td>Business services</td><td rowspan="6">Sales, marketing, logistics, retail and other business services</td><td rowspan="10">Post-production</td></tr>
<tr><td>Logistics, distribution & transportation</td></tr>
<tr><td>Retail</td></tr>
<tr><td>Sales, marketing & support</td></tr>
<tr><td>Customer contact centre</td></tr>
<tr><td>Shared services centre</td></tr>
<tr><td>ICT & internet infrastructure</td><td rowspan="4">Technical services, maintenance & training</td></tr>
<tr><td>Technical support centre</td></tr>
<tr><td>Education & training</td></tr>
<tr><td>Maintenance & servicing</td></tr>
</table>

*Note: * For chemicals sector only.*
Sources: fDi Markets database; authors' own classification.

Table 10: Functional specialisation in trade – business functions and ISCO88 occupations

Occupations	1-digit ISCO88	3-digit ISCO88	Business functions	Example of occupation
Legislators, senior officials and managers	1	111–131	Manage-ment	Directors and chief executives
Professionals	2	211–235	R&D	Mathematicians, statisticians and related professionals
		241–247	Marketing	Business professionals
Technicians and associate professionals	3	311–323, 331–334	R&D	Physical and engi-neering science technicians
		341–348	Marketing	Business services agents and trade brokers
Clerks	4	411–422	Marketing	Client information clerks
Service workers and shop and market sales workers	5	511–522	Marketing	Shop, stall and market sales-persons and demonstrators
Skilled agri-cultural and fishery workers	6	611–615	Fabrication	Fishery workers, hunters and trappers
Craft and related trades workers	7	711–744	Fabrication	Electrical and electronic equip-ment mechanics and fitters
Plant and machine operators and assemblers	8	811–834	Fabrication	Automated-assembly-line and industrial-robot operators
Elementary occupations	9	911–916	Marketing	Street vendors and related workers
		921–933	Fabrication	Manufacturing labourers

Source: Authors' elaboration based on Timmer et al. (2019), 'Online appendix with replication files'.

Table 11: Working conditions and underlying questions

Working condition	**Sub-components**	**Questions**
Physical environment	Physical health risks	Vibrations from hand tools, machinery
		Noise so loud that you would have to raise your voice to talk to people
		High temperatures which make you perspire even when not working
		Low temperatures whether indoors or outdoors
		Breathing in smoke, fumes, powder or dust
		Breathing in vapours
		Handling or being in skin contact with chemical products or substances
		Tobacco smoke from other people
		Handling or being in direct contact with materials which could be infectious, such as waste etc
	Physical demands	Tiring or painful positions
		Lifting or moving people
		Carrying or moving heavy loads
		Repetitive hand or arm movements
Work intensity		Working at very high speed
		Working to tight deadlines
Working time quality	Work extensity	Long working hours
		Long working days
	Atypical working time	Night work
		Saturday work
		Sunday work
		Shift: differently weighted shifts (1 = permanent shift; 0.75 = rotating shift; 0.5 = other shift; 0.25 = split shift)
	Working time arrangements	Working time arrangements (combination of who controls WTA and how regular such changes occur)
Social environment	Adverse social behaviour	Exposure to verbal abuse
		Exposure to unwanted sexual attention
		Exposure to physical violence
		Exposure to sexual harassment
		Exposure to bullying/harassment
	Social support	Help and support from colleagues
		Help and support from your manager

Working condition	Sub-components	Questions
Skills and discretion	Cognitive dimension	Solving unforeseen problems
		Carrying out complex tasks
		Learning new things
		Working with computers, smartphones and laptops
		Ability to apply your own ideas in work
	Decision latitude	Ability to choose or change order of tasks
		Ability to choose or change speed or rate of work
		Ability to choose or change methods of work
		Having a say in choice of work colleagues
	Organisational participation	Consulted before objectives are set for own work
		Involved in improving the work organisation of work processes of own department
		Ability to influence decisions that are important for your work
Prospects		My job offers good prospects for career advancement
		I might lose my job in the next six months (recoded)
		If I were to lose my current job, it would be easy for me to find a new job of similar salary

Source: EWCS-2010 and EWCS-2015.

A.2 Additional results

The specifications tests as to whether to include country-, industry- and time-fixed effects all decided in favour of including them. Therefore, we consider the fixed-effects model as the appropriate econometric specification and report the pooled regressions in the Appendix for the sake of completeness in Table 12 for the FDI-based RFS measures and in Table 13 for the trade-based RFS measures.

Table 12: Pooled OLS regression results, FDI-based functional specialisation and wages, 2003–2019

	Dependent variable: real wages (log)													
	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	**(A2)**	**(A3)**	**(A4)**	**(B3)**	**(B4)**	**(C3)**	**(C4)**	**(D1)**	**(D2)**	**(D3)**	**(D4)**	**(E3)**	**(E4)**
Functional measures														
RFS fabrication	−0.2221*** (0.0163)		−0.2693*** (0.0196)		−0.2639*** (0.0201)		−0.2352*** (0.0195)		−0.1743*** (0.0158)		−0.2036*** (0.0203)		−0.0649*** (0.0161)	
RFS R&D		0.1122*** (0.0117)	0.1043*** (0.0110)		0.0950*** (0.0109)		0.0769*** (0.0105)			0.0774*** (0.0099)	0.0700*** (0.0097)		0.0447*** (0.0079)	
RFS factory-HQ ratio				−0.2481*** (0.0151)		−0.2400*** (0.0157)		−0.2114*** (0.0154)				−0.1773*** (0.0146)		−0.0474*** (0.0117)
Labour productivity														
Labour productivity	0.8422*** (0.0096)	0.8207*** (0.0134)	0.8106*** (0.0131)	0.7935*** (0.0158)	0.8027*** (0.0132)	0.7891*** (0.0157)	0.7653*** (0.0141)	0.7631*** (0.0168)	0.7250*** (0.0119)	0.6981*** (0.0146)	0.7058*** (0.0145)	0.6966*** (0.0168)	0.5059*** (0.0163)	0.4872*** (0.0203)
GVC integration														
Backward GVC participation					−0.2077*** (0.0639)	−0.0919 (0.0728)	−0.1431** (0.0635)	−0.0338 (0.0741)	−0.2013*** (0.0563)	−0.3574*** (0.0594)	−0.2736*** (0.0616)	−0.2855*** (0.0712)	−0.0751 (0.0543)	−0.1489** (0.0638)
Forward GVC participation					0.2564** (0.1042)	0.3048*** (0.1087)	0.1913* (0.1077)	0.3260*** (0.1146)	−0.5179*** (0.0820)	−0.6762*** (0.1025)	−0.5202*** (0.1008)	−0.6185*** (0.1082)	−0.1234 (0.0834)	−0.2314*** (0.0892)
Supply-side factors														
Human capital index					0.3978*** (0.0648)	0.4239*** (0.0805)	0.4245*** (0.0711)	0.4824*** (0.0973)	0.4688*** (0.0564)	0.4721*** (0.0713)	0.4054*** (0.0697)	0.5544*** (0.0919)	0.4165*** (0.0574)	0.4846*** (0.0784)
High-low skilled labour ratio					−0.0279*** (0.0107)	−0.0375*** (0.0122)	−0.0188* (0.0106)	−0.0335*** (0.0123)	0.0381*** (0.0073)	0.0195** (0.0097)	0.0241** (0.0095)	0.0083 (0.0111)	0.0043 (0.0089)	−0.0041 (0.0107)
Labour market and structural features														
Unionisation rate							0.3455*** (0.0372)	0.2775*** (0.0448)	0.3631*** (0.0284)	0.3851*** (0.0340)	0.2709*** (0.0324)	0.1958*** (0.0376)	0.0711*** (0.0271)	0.0533* (0.0310)
Job vacancy rate							−2.9381*** (0.9038)	−1.2851 (1.0507)	−3.6993*** (0.6832)	−3.3338*** (0.8588)	−3.0059*** (0.8581)	−1.3009 (0.9492)	−1.2762* (0.6763)	−0.7541 (0.7472)
Long-term unemployment							−1.0249*** (0.2372)	−0.2981 (0.2977)	−1.3833*** (0.1703)	−1.4248*** (0.2055)	−1.3805*** (0.2085)	−0.7219*** (0.2463)	−0.2909* (0.1738)	−0.2135 (0.2168)
Employment (log)									0.0230*** (0.0038)	0.0062 (0.0044)	0.0192*** (0.0045)	0.0106** (0.0049)	−0.0154*** (0.0035)	−0.0227*** (0.0039)
Share of manufacturing									−0.0106*** (0.0015)	−0.0118*** (0.0017)	−0.0096*** (0.0017)	−0.0100*** (0.0020)	0.0055*** (0.0015)	0.0053*** (0.0017)

	Dependent variable: real wages (log)													
	A. Base model				B. Supply-side model		C. Labour institutions model		D. Structural model				E. FDI ratio model	
	(A1)	(A2)	(A3)	(A4)	(B3)	(B4)	(C3)	(C4)	(D1)	(D2)	(D3)	(D4)	(E3)	(E4)
Female employment share									−0.4392*** (0.0321)	−0.6616*** (0.0458)	−0.5969*** (0.0437)	−0.7289*** (0.0524)	−0.3995*** (0.0334)	−0.5139*** (0.0411)
Churning (enterprises)									−0.0094*** (0.0011)	−0.0113*** (0.0013)	−0.0116*** (0.0013)	−0.0132*** (0.0016)	−0.0040*** (0.0010)	−0.0040*** (0.0012)
Outward-to-inward FDI ratio														
FDI ratio													0.7326*** (0.0240)	0.7370*** (0.0301)
Observations	3,720	2,914	2,843	2,165	2,843	2,165	2,685	2,019	3,561	2,756	2,685	2,019	2,685	2,019
R-sq. Adj.	0.862	0.813	0.834	0.821	0.838	0.825	0.850	0.836	0.893	0.866	0.875	0.871	0.918	0.912
F-value	5870	3177	2767	2891	1488	1149	1086	809.0	2008	1126	1135	927.2	2137	1672
F-test for equality of coefficients														
(RFS fabrication = RFS R&D)														
Prob > F														

Notes: All explanatory variables enter the regressions with a 1-period lag. No fixed effects included (pooled regression).
****, ** and * indicate statistical significance at the 1%, 5% and 10% level respectively. Robust standard errors in parentheses.*
All regressions estimated with STATA using the reghdfe command.

Table 13: Pooled OLS regression results, trade-based functional specialisation and wages, 2000–2014

	Dependent variable: real wages (log)															
	A. Base model				B. Supply side model		C. Labour institutions model		D. Structural model				E. Model with FDI ratio		E. FDI ratio model	
	(A1)	(A2)	(A3)	(A4)	(B3)	(B4)	(C3)	(C4)	(D1)	(D2)	(D3)	(D4)	(E1)	(E2)	(E3)	(E4)
Functional measures																
RFS fabrication	−0.1496*** (0.0161)		−0.4376*** (0.0348)		−0.3958*** (0.0344)		−0.2559*** (0.0349)		−0.2055*** (0.0191)		−0.3003*** (0.0320)		−0.0504*** (0.0169)		−0.0778*** (0.0250)	
RFS R&D		−0.0426*** (0.0146)	0.3137*** (0.0318)		0.2553*** (0.0319)		0.1014*** (0.0336)			−0.1316*** (0.0201)	0.1196*** (0.0338)			−0.0292 (0.0190)	0.0340 (0.0292)	
RFS factory-HQ ratio				−0.2378*** (0.0272)		−0.1987*** (0.0272)		−0.0912*** (0.0273)				−0.1475*** (0.0266)				−0.0447** (0.0211)
Labour productivity																
Labour productivity	0.8684*** (0.0092)	0.8711*** (0.0096)	0.8375*** (0.0106)	0.8395*** (0.0108)	0.8357*** (0.0107)	0.8370*** (0.0110)	0.7876*** (0.0117)	0.7858*** (0.0121)	0.7123*** (0.0119)	0.7193*** (0.0123)	0.7038*** (0.0125)	0.6957*** (0.0129)	0.5310*** (0.0124)	0.5298*** (0.0130)	0.5292*** (0.0130)	0.5234*** (0.0126)
GVC integration																
Backward GVC participation					−0.1722*** (0.0577)	−0.1687*** (0.0591)	−0.1673*** (0.0553)	−0.1515*** (0.0566)	−0.1363** (0.0537)	−0.1651*** (0.0541)	−0.1452*** (0.0536)	−0.2170*** (0.0522)	0.0227 (0.0426)	0.0178 (0.0426)	0.0196 (0.0427)	0.0063 (0.0416)
Forward GVC participation					−0.0853 (0.0987)	−0.0803 (0.0986)	−0.0965 (0.1019)	−0.0961 (0.1016)	−0.7468*** (0.0914)	−0.6948*** (0.0904)	−0.7622*** (0.0916)	−0.7279*** (0.0906)	−0.3325*** (0.0764)	−0.3138*** (0.0758)	−0.3381*** (0.0770)	−0.3250*** (0.0770)
Supply-side factors																
Human capital index					0.4435*** (0.0570)	0.3905*** (0.0563)	0.4435*** (0.0571)	0.3518*** (0.0558)	0.4940*** (0.0536)	0.5758*** (0.0543)	0.4409*** (0.0543)	0.4576*** (0.0550)	0.3963*** (0.0414)	0.4135*** (0.0407)	0.3815*** (0.0424)	0.3804*** (0.0421)
High-low skilled labour ratio					−0.0185** (0.0082)	−0.0100 (0.0084)	0.0014 (0.0077)	0.0118 (0.0078)	0.0670*** (0.0081)	0.0640*** (0.0082)	0.0679*** (0.0081)	0.0657*** (0.0083)	0.0271*** (0.0062)	0.0258*** (0.0062)	0.0275*** (0.0062)	0.0263*** (0.0062)
Labour market and structural features																
Unionisation rate							0.4524*** (0.0323)	0.4729*** (0.0332)	0.5619*** (0.0289)	0.5867*** (0.0306)	0.5312*** (0.0302)	0.5018*** (0.0307)	0.1383*** (0.0275)	0.1371*** (0.0294)	0.1309*** (0.0296)	0.1144*** (0.0276)
Job vacancy rate							−4.7402*** (0.8813)	−3.9900*** (0.9020)	−5.5205*** (0.8330)	−5.8034*** (0.8366)	−5.3591*** (0.8356)	−5.3463*** (0.8429)	−1.6879** (0.7276)	−1.6947** (0.7296)	−1.6538** (0.7312)	−1.5578** (0.7386)
Long-term unemployment							−1.5128*** (0.2046)	−1.4656*** (0.2171)	−2.0716*** (0.1937)	−2.1125*** (0.2003)	−2.0948*** (0.1932)	−2.2338*** (0.1975)	−1.0656*** (0.1527)	−1.0609*** (0.1547)	−1.0753*** (0.1543)	−1.0889*** (0.1543)
Employment (log)									0.0535*** (0.0050)	0.0444*** (0.0052)	0.0475*** (0.0051)	0.0173*** (0.0038)	−0.0052 (0.0044)	−0.0085* (0.0048)	−0.0067 (0.0048)	−0.0149*** (0.0030)
Share of manufacturing									−0.0153*** (0.0014)	−0.0169*** (0.0014)	−0.0150*** (0.0013)	−0.0167*** (0.0014)	0.0027*** (0.0010)	0.0026** (0.0010)	0.0027*** (0.0010)	0.0027*** (0.0010)

	Dependent variable: real wages (log)															
	A. Base model				B. Supply side model		C. Labour institutions model		D. Structural model				E. Model with FDI ratio		E. FDI ratio model	
	(A1)	(A2)	(A3)	(A4)	(B3)	(B4)	(C3)	(C4)	(D1)	(D2)	(D3)	(D4)	(E1)	(E2)	(E3)	(E4)
Female employment share									−0.4028*** (0.0301)	−0.3907*** (0.0323)	−0.4388*** (0.0336)	−0.5094*** (0.0328)	−0.3765*** (0.0246)	−0.3740*** (0.0267)	−0.3868*** (0.0277)	−0.4045*** (0.0263)
Churning (enterprises)									−0.0098*** (0.0011)	−0.0105*** (0.0012)	−0.0098*** (0.0011)	−0.0109*** (0.0012)	−0.0033*** (0.0008)	−0.0033*** (0.0008)	−0.0033*** (0.0008)	−0.0034*** (0.0008)
Outward-to-inward FDI ratio																
FDI ratio													0.7162*** (0.0231)	0.7271*** (0.0232)	0.7140*** (0.0224)	0.7278*** (0.0211)
Observations	3,748	3,748	3,748	3,748	3,748	3,748	3,598	3,598	3,598	3,598	3,598	3,598	3,598	3,598	3,598	3,598
R-sq. Adj.	0.853	0.849	0.858	0.853	0.860	0.855	0.871	0.866	0.895	0.892	0.895	0.891	0.930	0.930	0.930	0.930
F-value	5212	4177	4464	5373	2429	2222	1882	1718	2279	2207	2113	2046	3229	3290	3075	3181
F-test for equality of coefficients																
(RFS fabrication = RFS R&D)																
Prob > F																

Notes: All explanatory variables enter the regressions with a 1-period lag. No fixed effects included (pooled regression).
****, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses.*
All regressions estimated with STATA using the reghdfe command.

Table 14: Correlation between key variables in the analysis of non-wage working conditions

	Physical environment	Work intensity	Working time quality	Social environment	Skills & discretion	Prospects	D1.RFS fabrication	D1.RFS R&D	D1.labour productivity (ln)	D1.backward GVC participation	D1.forward GVC participation	D1.unionisation rate	D1.job vacancy rate	D1.long-term unemployment	D1.employment (ln)	D1.share of manufacturing	D1.churning (enterprises)	D1.real GDP per capita (ln)
Physical environment	1																	
Work intensity	0.270***	1																
Working time quality	0.227***	0.149***	1															
Social environment	0.157***	0.152***	0.072***	1														
Skills & discretion	−0.225***	−0.010***	−0.080***	−0.169***	1													
Prospects	−0.140***	−0.078***	−0.005	−0.123***	0.371***	1												
D1.RFS fabrication	0.020	0.024*	−0.01	−0.016	−0.002	−0.003	1											
D1.RFS R&D	−0.034**	−0.002	−0.01	−0.009	−0.021	−0.014	0.011	1										
D1.labour productivity (ln)	−0.022*	−0.002	0.006	0.009	0.046***	−0.008	0.137***	−0.026*	1									
D1.backward GVC participation	0.035***	0.008	−0.041***	0.044***	−0.006	0.001	0.084***	−0.014	−0.123***	1								
D1.forward GVC participation	0.014	0.025**	0.024*	−0.006	0.003	−0.020	0.075***	−0.093***	0.258***	−0.523***	1							
D1.unionisation rate	0.002	−0.071***	−0.031**	0.040***	−0.048***	0.003	−0.384***	−0.160***	0.004	0.002	−0.044***	1						
D1.job vacancy rate	0.001	−0.006	0.007	−0.017	−0.011	−0.060***	0.021	0.014	0.067***	−0.014	−0.003	0.037***	1					
D1.long-term unemployment	0.018	−0.011	−0.019	0.003	−0.006	−0.110***	0.080***	−0.032**	0.247***	0.221***	−0.074***	0.090***	−0.020	1				
D1.employment (ln)	−0.003	−0.023*	0.070***	−0.006	−0.014	0.026**	−0.054***	−0.055***	−0.126***	−0.108***	0.041***	0.039***	0.014	−0.249***	1			
D1.share of manufacturing	−0.023*	0.007	0.042***	0.006	−0.008	−0.071***	−0.007	−0.039**	0.349***	−0.186***	0.148***	0.022*	−0.013	−0.002	0.075***	1		
D1.churning (enterprises)	−0.024*	−0.017	0.004	−0.022*	0.052***	0.035***	0.017	0.022	−0.116***	0.095***	−0.071***	−0.088***	−0.087***	−0.055***	−0.029**	−0.021	1	
D1.real GDP per capita (ln)	−0.032**	−0.036***	0.058***	0.001	−0.011	−0.005	−0.096***	−0.042***	0.195***	−0.192***	0.066***	0.243***	0.204***	−0.254***	0.152***	0.540***	0.051***	1

*Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively.*

Table 15: Multilevel regression results: FDI-based functional specialisation and other working conditions, pooled sample for 2010 and 2015 (D3)

	(1) Physical environment	(2) Work intensity	(3) Worktime quality	(4) Social environment	(5) Skills & discretion	(6) Prospects
Functional measures						
D.RFS fabrication	−0.802** (−2.360)	−0.605*** (−2.943)	−0.187 (−0.630)	0.105 (1.015)	0.087 (0.357)	−0.191 (−0.895)
D.RFS R&D	0.094 (1.544)	0.029 (0.622)	0.093 (1.025)	−0.035 (−1.136)	0.119 (1.601)	−0.043 (−0.747)
Worker characteristics						
Female (yes = 1)	−0.602*** (−6.460)	0.029 (0.424)	−0.324*** (−5.288)	0.034 (1.326)	−0.305*** (−6.397)	−0.175*** (−4.142)
Migrant (yes = 1)	0.115 (1.285)	0.038 (0.423)	0.098* (1.913)	0.054* (1.675)	−0.218*** (−2.795)	−0.035 (−0.573)
15–24 years old	0.123 (1.159)	0.038 (0.386)	0.258*** (2.579)	0.036 (0.843)	−0.351*** (−3.580)	0.555*** (5.639)
25–49 years old	0.036 (0.630)	0.057 (1.193)	0.130*** (3.522)	0.028 (1.391)	−0.040 (−0.883)	0.384*** (8.372)
ISCO-medium	−0.348*** (−3.552)	−0.219*** (−4.847)	−0.332*** (−5.531)	−0.025 (−1.281)	0.684*** (6.950)	0.277*** (5.323)
ISCO-high	−1.220*** (−13.146)	−0.321*** (−5.371)	−0.394*** (−5.354)	−0.065*** (−3.264)	1.785*** (19.178)	0.634*** (14.645)
Firm characteristics						
Firm size: medium	0.077 (1.251)	0.070 (0.944)	0.084 (1.354)	0.031 (1.309)	−0.279*** (−3.439)	−0.048 (−1.083)
Firm size: large	0.002 (0.030)	0.167** (2.096)	0.305*** (4.691)	0.020 (0.722)	−0.051 (−0.525)	0.030 (0.523)
Firm type: private	−0.062 (−0.406)	0.220* (1.882)	0.041 (0.326)	0.065 (1.599)	−0.156* (−1.724)	−0.101 (−1.405)
Firm type: other	0.082 (0.396)	0.422*** (3.364)	0.193* (1.717)	0.102 (1.010)	−0.066 (−0.400)	−0.146 (−0.794)
Supply-side factors						
D.Labour productivity (ln)	−0.085 (−0.682)	0.177*** (2.944)	0.098 (0.621)	0.028 (0.787)	−0.017 (−0.139)	0.085 (1.226)
GVC integration						
D.backward GVC participation	0.610 (0.670)	1.309 (1.146)	0.509 (0.456)	1.091** (2.512)	−1.701** (−1.961)	0.443 (0.610)
D.forward GVC participation	4.186** (2.546)	2.387 (1.273)	2.005 (1.166)	0.464 (0.559)	−1.106 (−0.512)	0.671 (0.482)
Labour market and structural features						
D.unionisation rate	0.021 (0.009)	−0.963 (−0.320)	1.330 (0.539)	−1.021* (−1.840)	−2.250 (−0.906)	7.788*** (7.299)
D.job vacancy rate	0.478 (0.062)	−5.247 (−0.886)	−1.561 (−0.489)	−0.687 (−0.479)	−4.729 (−0.972)	0.111 (0.026)
D.long-term unemployment	2.415 (0.731)	−4.491 (−1.268)	−4.870* (−1.712)	2.038* (1.762)	−1.379 (−0.506)	−7.282*** (−4.315)
D.empoyment (ln)	−0.006 (−0.039)	0.122 (0.843)	−0.082 (−0.714)	−0.049 (−0.970)	−0.240*** (−3.074)	−0.119 (−1.501)
D.value-added share of manufacturing	−0.031** (−2.521)	−0.057*** (−3.336)	0.013* (1.662)	−0.008 (−1.439)	−0.037** (−2.236)	0.001 (0.137)

	(1) Physical environment	(2) Work intensity	(3) Worktime quality	(4) Social environment	(5) Skills & discretion	(6) Prospects
D.churning (enterprises)	−0.006 (−0.328)	−0.000 (−0.019)	0.005 (0.259)	0.005 (1.377)	0.007 (0.700)	−0.012 (−1.582)
Country characteristics						
D.real GDP per capita (ln)	1.602*** (2.762)	−0.343 (−0.744)	0.017 (0.040)	0.693*** (4.514)	−0.565** (−1.967)	−0.783*** (−2.825)
Wave FE	−0.075 (−0.471)	0.115 (1.035)	0.026 (0.490)	−0.033 (−1.019)	0.265*** (2.998)	0.263*** (2.786)
Constant	0.945*** (3.967)	0.043 (0.232)	0.000 (0.002)	−0.173** (−2.374)	−0.709*** (−4.668)	−0.393*** (−2.821)
Random effects						
Industry	0.092***	0.029**	0.071***	0.011***	0.029*	0.023***
Country	0.019*	0.091**	0.064**	0.002*	0.158***	0.042**
Observations	3,847	3,885	3,884	3,913	3,908	3,913
Number of groups	24	24	24	24	24	24

*Notes: ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses. Weights are used in estimations.*

A.3 First-stage results and instrumental variable tests for the wage model

Section 4 in the main text presented the results of several IV panel fixed-effects models. This Appendix supplements these results with the corresponding first stage results and some tests for the validity of our instruments. For this we focus on our preferred model, which is the structural model (specifications D). Table 16 reproduces the results of specification D.1 in the main text including the RFS in fabrication as functional specialisation measure (left-hand side) along with the first stage (right-hand side).

As a reminder, the instrument used here is the weighted average of the RFS of those five countries outside the EU sample which have the most similar RFS values at the country-industry level. It is statistically significant at the 1% level. The main points to be emphasised in the first-stage regression are the high statistical significance of the instrument (out-of-sample RFS fabrication) and the F-test of the regression. The latter amounts to 630.2, which exceeds by far 10, the rule-of-thumb value for a sufficient correlation of the instruments with the endogenous regressors.

Hence, the out-of-sample RFS variable is a relevant instrument. This was to be expected, since we constructed a synthetic instrument that by construction is a ‘sharp’ (Cherif et al., 2018) instrument and strongly related to the RFS in fabrication of the respective country-industry observation. A more formal test is the Kleibergen-Paap statistic, which has as the null hypothesis that the first stage regression is only weakly identified. This hypothesis is clearly rejected.

A drawback of our primary instrument is that the first stage is exactly identified, so that we cannot test the exclusion restriction. To remedy this, we rerun the model in a slightly modified version (D.1') using the RFS of three similar countries separately.[1] Specification D.1' which uses these alternative instruments yields qualitatively identical results of the relevance of the instruments. Moreover, they allow for testing the exogeneity of the instruments. In this respect, the Hanson test statistics, with the null hypothesis that the instruments are uncorrelated with the error term of the regression, cannot be rejected at conventional levels of significance.

Given the tests for the weakness of the instrument and for exogeneity, we can conclude that the instrument is a valid one.

To test the validity of the instrument for the RFS in R&D we proceed in exactly the same manner as for the RFS in fabrication (Table 18 and Table 19).

Both tests for the validity of the instrument – relevance and exogeneity – are also passed for the specifications with the RFS in R&D as functional specialisation measure.

1 We use only three out of the top five correlated RFS values of out-of-sample countries because including 'country 2' in the specification for R&D (see below) delivers very different results. For this reason we limit the instruments to three and opt for the uneven numbers. For the model featuring the RFS in fabrication the choice of countries does not matter at all. However, we also use the 'uneven' countries here to have symmetric IV strategies.

Table 16: IV regressions and first stage results – RFS in fabrication (model D.1), main instrument

Instrument: Weighted average of the RFS of the most similar 5 out-of-sample countries			
Dependent variable	**(D1) ln wage**		**(First stage) RFS fabr.**
RFS fabrication	−0.1115*** (0.0250)	Out-of-sample RFS fabrication	0.7545*** (0.0301)
Labour productivity	0.3778*** (0.0297)	Labour productivity	0.0477*** (0.0168)
Backward GVC participation	−0.2138*** (0.0781)	Backward GVC participation	0.5272*** (0.0958)
Forward GVC participation	−0.2177* (0.1243)	Forward GVC participation	0.4312*** (0.1378)
Human capital index	0.6124*** (0.2146)	Human capital index	−0.2126 (0.4068)
High-low skilled labour ratio	−0.0040 (0.0127)	High-low skilled labour ratio	−0.0241** (0.0104)
Unionisation rate	−0.2245 (0.1567)	Unionisation rate	−0.5032** (0.2470)
Job vacancy rate	0.0339 (0.5971)	Job vacancy rate	1.4278 (0.9940)
Long-term unemployment	−1.0699*** (0.1533)	Long-term unemployment	0.6024** (0.2695)
Employment (log)	0.0127* (0.0074)	Employment (log)	0.0941*** (0.0089)
Value-added share of manufacturing	0.0102*** (0.0038)	Value-added share of manufacturing	−0.0038 (0.0031)
Female employment share	−0.1917*** (0.0556)	Female employment share	0.1183* (0.0636)
Churning (enterprises)	0.0001 (0.0009)	Churning (enterprises)	0.0021 (0.0013)
Observations	3,561	Observations	3,561
R-squared	0.345	R-squared	.
F-value	0.3455	F-value	630.2
Instrumental variable statistics			
Weak instrument test			
Kleibergen-Paap LM stat.	319.97		
Chi-sq. p-value	0.0000		
Overidentification test (test for exogeneity of instruments)			
Hansen J statistic	n./a.		
Chi-sq. p-value			

*Notes: All explanatory variables enter the regressions with a 1-period lag. All regressions include country-, industry- and year-fixed effects. ***, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses. All regressions estimated with STATA using the ivreghdfe command.*

Table 17: IV regressions and first stage results – RFS in fabrication (model D.1’), alternative instrument

Instrument: RFS of similar out-of-sample countries			
Dependent variable	**(D1’) ln wage**		**(First stage) RFS fabr.**
RFS fabrication	−0.0908*** (0.0228)	RFS fabrication instr. country 1	0.3611*** (0.0193)
		RFS fabrication instr. country 3	0.2625*** (0.0175)
		RFS fabrication instr. country 5	−0.0200 (0.0161)
Labour productivity	0.3766*** (0.0298)	Labour productivity	0.0494*** (0.0167)
Backward GVC participation	−0.2265*** (0.0784)	Backward GVC participation	0.4093*** (0.0929)
Forward GVC participation	−0.2320* (0.1236)	Forward GVC participation	0.3155** (0.1335)
Human capital index	0.6107*** (0.2131)	Human capital index	−0.0634 (0.3928)
High-low skilled labour ratio	−0.0032 (0.0127)	High-low skilled labour ratio	−0.0301*** (0.0103)
Unionisation rate	−0.2170 (0.1553)	Unionisation rate	−0.4589* (0.2409)
Job vacancy rate	−0.0066 (0.5919)	Job vacancy rate	1.3892 (1.0055)
Long-term unemployment	−1.0810*** (0.1516)	Long-term unemployment	0.5667** (0.2619)
Employment (log)	0.0104 (0.0073)	Employment (log)	0.0972*** (0.0086)
Value-added share of manufacturing	0.0103*** (0.0038)	Value-added share of manufacturing	−0.0046 (0.0029)
Female employment share	−0.1942*** (0.0555)	Female employment share	0.1664** (0.0655)
Churning (enterprises)	0.0000 (0.0009)	Churning (enterprises)	0.0034** (0.0014)
Observations	3,561	Observations	3,561
R-squared	0.350	R-squared	
F-value	0.3505	F-value	241.09
Instrumental variable statistics Weak instrument test			
Kleibergen-Paap LM stat.	358.598		
Chi-sq. p-value	0.0000		
Overidentification test (test for exogeneity of instruments)			
Hansen J statistic	3.694		
Chi-sq. p-value	0.1577		

Notes: All explanatory variables enter the regressions with a 1-period lag. All regressions include country, industry and year fixed effects.
****, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses.*
All regressions estimated with STATA using the ivreghdfe command.

Table 18: IV regressions and first stage results – RFS in R&D (model D.2), main instrument

Instrument: RFS of similar out-of-sample countries			
Dependent variable	**(D2) ln wage**		**(First stage) RFS R&D**
RFS R&D	0.0115 (0.0081)	Out-of-sample RFS R&D	0.8344*** (0.0182)
Labour productivity	0.3557*** (0.0352)	Labour productivity	−0.0519** (0.0247)
Backward GVC participation	−0.3274*** (0.0847)	Backward GVC participation	−0.5229*** (0.1465)
Forward GVC participation	−0.2776* (0.1592)	Forward GVC participation	0.1721 (0.3230)
Human capital index	0.8970*** (0.2586)	Human capital index	1.4888* (0.8575)
High-low skilled labour ratio	0.0067 (0.0173)	High-low skilled labour ratio	0.0827*** (0.0196)
Unionisation rate	−0.6495*** (0.1938)	Unionisation rate	0.7382* (0.4103)
Job vacancy rate	0.6296 (0.7360)	Job vacancy rate	1.3357 (1.7979)
Long-term unemployment	−0.9408*** (0.1813)	Long-term unemployment	−0.0578 (0.4155)
Employment (log)	0.0073 (0.0090)	Employment (log)	0.0055 (0.0139)
Value-added share of manufacturing	0.0125*** (0.0041)	Value-added share of manufacturing	−0.0002 (0.0042)
Female employment share	−0.2085*** (0.0745)	Female employment share	−0.2893*** (0.1049)
Churning (enterprises)	−0.0031** (0.0013)	Churning (enterprises)	0.0064** (0.0031)
Observations	2,756	Observations	2,756
R-sq. Adj.	33.78	R-sq. Adj.	.
F-value	0.3491	F-value	2,106.22
Instrumental variable statistics			
Weak instrument test			
Kleibergen-Paap LM stat.	635.60		
Chi-sq. p-value	0.0000		
Overidentification test (test for exogeneity of instruments):			
Hansen J statistic	n./a.		
Chi-sq. p-value			

Notes: All explanatory variables enter the regressions with a 1-period lag. All regressions include country, industry and year fixed effects.
****, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses.*
All regressions estimated with STATA using the ivreghdfe command.

Table 19: IV regressions and first-stage results – RFS in R&D (model D.2'), alternative instrument

Instrument: RFS of similar out-of-sample countries			
Dependent variable	**(D2') In wage**		**(first stage) RFS R&D**
RFS R&D	0.0209** (0.0088)	RFS fabrication instr. country 1	0.4741*** (0.0169)
		RFS fabrication instr. country 3	0.0860*** (0.0172)
		RFS fabrication instr. country 5	0.1459*** (0.0175)
Labour productivity	0.3557*** (0.0351)	Labour productivity	−0.0893*** (0.0260)
Backward GVC participation	−0.3261*** (0.0848)	Backward GVC participation	−0.6731*** (0.1603)
Forward GVC participation	−0.2827* (0.1595)	Forward GVC participation	−0.3503 (0.3635)
Human capital index	0.8682*** (0.2596)	Human capital index	1.2710 (0.8747)
High-low skilled labour ratio	0.0060 (0.0173)	High-low skilled labour ratio	0.0782*** (0.0211)
Unionisation rate	−0.6648*** (0.1951)	Unionisation rate	1.2791*** (0.4224)
Job vacancy rate	0.6306 (0.7354)	Job vacancy rate	1.1317 (1.8548)
Long-term unemployment	−0.9351*** (0.1816)	Long-term unemployment	−0.2758 (0.4340)
Employment (log)	0.0072 (0.0090)	Employment (log)	0.0113 (0.0137)
Value-added share of manufacturing	0.0125*** (0.0041)	Value-added share of manufacturing	0.0008 (0.0045)
Female employment share	−0.2070*** (0.0742)	Female employment share	−0.2790** (0.1109)
Churning (enterprises)	−0.0032** (0.0013)	Churning (enterprises)	0.0086*** (0.0032)
Observations	2,756	Observations	2,756
R-sq. Adj.	34.78	R-sq. Adj.	
F-value	0.3502	F-value	557.92
Instrumental variable statistics Weak instrument test			
Kleibergen-Paap LM stat.	650.03		
Chi-sq. p-value	0.0000		
Overidentification test (test for exogeneity of instruments):			
Hansen J statistic	4.157		
Chi-sq. p-value	0.1251		

Notes: All explanatory variables enter the regressions with a 1-period lag. All regressions include country, industry and year fixed effects.
****, ** and * indicate statistical significance at the 1%, 5% and 10% level, respectively. Robust standard errors in parentheses.*
All regressions estimated with STATA using the ivreghdfe command.

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