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## Minimum Wage Politics in the Knowledge Economy: Evidence from Europe

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# Minimum Wage Politics in the Knowledge Economy: Evidence from Europe

## Abstract

The emergence of the knowledge economy has transformed European labour markets and the political economy of social policy. Yet, despite the growing use of statutory minimum wages (SMWs) in Europe, their relationship to the knowledge economy has not been comprehensively analysed. This paper examines how knowledge-economy development is associated with the presence and levels of SMWs in 21 European countries from 1995 to 2021. Using probit models and fixed-effects panel regressions, we find that SMW outcomes depend more on the specific knowledge-economy trajectory than on its overall degree. While the knowledge economy index is weakly associated with SMW outcomes, its service- and manufacturing-oriented dimensions show opposing relationships with SMW presence and levels. Random forest analyses indicate that knowledge-economy proxies are among the strongest predictors of SMW outcomes.

## JEL classification

J3, J38, O33

## Keywords

comparative political economy, knowledge economy, labour market politics, minimum wages

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# 1 Introduction

Advanced economies have undergone a profound structural transformation. The transition towards a knowledge economy, driven by technological innovation and digitalisation, has reshaped labour markets (Hall 2024; Powell and Snellman 2004). A large literature links these developments to rising inequality, reduced redistribution, and labour market polarisation (Acemoglu et al. 2001; Autor et al. 2003; Brynjolfsson and McAfee 2016; Goos et al. 2009, 2014; Iversen and Soskice 2019; Kristal and Cohen 2016; Thewissen et al. 2018).

At the same time, statutory minimum wages (SMWs) have become an important labour market policy in many advanced capitalist democracies (ACDs), including Europe. While several European countries have had minimum wages for decades (e.g., the Netherlands since 1969), others introduced them more recently, including the UK in 1999, Ireland in 2000, and Germany in 2015. Yet other countries, such as Austria, Denmark, and Italy, do not have SMWs. Meanwhile, many countries with SMWs have increased their wage floors. These developments have generated considerable academic interest in explaining SMW introduction and levels. Existing research highlights the importance of political parties and collective bargaining (Dingeldey et al. 2021; Meardi and Seghezzi 2025; Meyer 2016; Kozák and Picot 2025; Rueda 2008; Zavodny 2020).

Despite growing attention to both developments, less attention has been paid to their relationship. Does, and if so to what extent, the transition to the knowledge economy affect the presence and levels of SMWs? This paper addresses this question by examining the relationship between the knowledge economy and SMWs in Europe. Specifically, it analyses whether and how the knowledge economy is associated with the presence and levels of SMWs and assesses its role relative to other explanatory factors.

We make three contributions. First, we provide one of the first analyses of the relationship between the knowledge economy and SMWs. Second, we distinguish between two different dimensions of knowledge-based development (Baccaro and Pontusson 2016; Baccaro et al. 2022; Beramendi et al. 2015; Hassel and Palier 2021, 2025). Following Diessner et al. (2025), we differentiate between a service-oriented dimension, based on information and communication technology (ICT)-intensive and highly skilled services, and a manufacturing-oriented dimension, based on innovation, automation, and technician-intensive production. Third, we assess the importance of knowledge-economy characteristics relative to collective bargaining, political, and labour market factors commonly used in the SMW literature.

To do so, we compile a novel dataset covering 21 European countries between 1995 and 2021 with measures of knowledge-economy development and collective bargaining, political, and labour market characteristics. We employ probit models for SMW presence, fixed-effects panel models for SMW levels, and random forests to assess the relative importance of explanatory factors. Our results suggest that the relationship between the knowledge economy and SMWs is not uniform. The service- and manufacturing-oriented dimensions are associated with opposing SMW outcomes, indicating that distinct forms of knowledge-economy development have different implications for SMW presence and levels. While collective bargaining institutions, particularly bargaining coverage and union density, remain important predictors of SMW outcomes, knowledge-economy variables rank among the strongest predictors of SMW presence and levels.

The next section reviews the literature on the knowledge economy and SMW politics, and develops our theoretical expectations. We then present the data and methodological approach before presenting our empirical results. The final section discusses the results and concludes.

## 2 Literature review

The literature on the knowledge economy and the literature on SMWs have largely developed separately. Research on the former has examined how technological change and the expansion of knowledge-intensive activities have transformed labour markets and distribution, while research on the latter has focused primarily on the institutional and political factors associated with SMW introduction and levels. Bringing these literatures together raises the question of how changes associated with the knowledge economy relate to SMW outcomes.

### 2.1 The knowledge economy and labour market polarisation

The knowledge economy refers to a structural shift from economies centred on the manufacturing of standardised goods towards economies primarily based on services and high-skilled labour, driven by ICT diffusion. Powell and Snellman (2004, 201) define it as “production and services based on knowledge-intensive activities that contribute to an accelerated pace of technological and scientific advance as well as equally rapid obsolescence”. While this shift began earlier, Hall (2024) argues that the turn of the millennium marked the transition toward knowledge-based growth as the dominant model. This transition was driven by the widespread adoption of ICT, rising investment in intangible assets, and increasing outsourcing and offshoring, which together resulted in highly integrated global value chains.

In contrast to postwar manufacturing-based Fordism, characterised by wage compression and income gains concentrated in lower-wage groups, the knowledge economy is associated with rising income and wealth inequalities (Brynjolfsson and McAfee 2016; Hope and Martelli 2019; Kristal and Cohen 2015; Thewissen et al. 2018). Automation and offshoring have contributed to the decline in well-paid, lower-skilled routine manufacturing and clerical jobs, while the expansion of ICT has increased demand for tertiary-educated workers and created new high-paid employment opportunities at the upper end of the labour market. Non-college graduates with lower skills, in turn, are pushed into low-wage employment in a growing, precarious service sector (Autor and Katz 1999; Autor et al. 2003; Goos et al. 2009, 2014). These shifts in employment structure have coincided with a weakening of the institutions that traditionally sustained wage compression, most notably rapid deunionization and declining collective bargaining coverage (Acemoglu et al. 2001; Baccaro and Howell 2017; Kristal and Cohen 2016; Thelen 2014).

These changes in the distribution of economic opportunities have implications for political support for redistribution. Some scholars argue that voters in ACDs are less supportive of redistribution than under industrial Fordism. Iversen and Soskice (2015, 2019) show that many voters perceive themselves as beneficiaries of the knowledge economy, and Wren and Rehm (2014) find that high-skilled workers in internationally exposed sectors are concerned about competitiveness, both of which weaken support for redistribution. Similarly, Guillaud (2013) shows that high-skilled workers are more likely than lower-skilled workers to oppose redistribution. Rehm (2020) goes further, arguing that the unequal distribution of risks and income in the knowledge economy undermines the future of the redistributive welfare state. More cautious accounts, however, argue that support for the welfare state remains broad, at least in Europe. At the same time, redistributive preferences are changing, as the new middle class increasingly favours social investment policies such as higher education spending and expanded daycare, compared with the traditional manual working class (Gingrich and Häusermann 2015; Häusermann et al. 2022). At the broader policy level, Hope and Limberg (2022) show that the expansion of knowledge-intensive sectors is associated with lower taxation of the rich.

Taken together, these arguments suggest that the rise of the knowledge economy could reduce political support for SMWs as support for redistribution declines. Yet, several countries have introduced or increased SMWs as the knowledge economy has expanded. This raises the possibility that the labour-market changes associated with the knowledge economy may instead generate pressure for stronger SMW policies, rather than reducing support for them.

## 2.2 Statutory minimum wages and their determinants

SMWs are legal wage floors below which employees cannot be paid, with certain exceptions. Their prevalence has increased substantially in recent decades, and as of 2026, minimum wage legislation was in force in 30 of 38 OECD countries (OECD 2026; Picot 2023).

Early research on SMW politics focused primarily on the United States and examined the determinants of wage floor increases. More recent research has expanded to other countries and considers both SMW levels and their introduction. US-based studies emphasise the roles of organised interests, partisanship, ideology, and economic conditions in SMW policy (Zavodny 2020). SMW increases are more likely under liberal Democratic majorities, in states with stronger unions and higher wage levels, and when unemployment is low. The literature, therefore, highlights lawmaker ideology (Bartels 2018; Poole and Rosenthal 1991, 2007), interest group influence (Bartels 2018; Bloch 1980; Sobel 1999), and economic conditions (Bartels 2018; Bloch 1980; Zavodny 1996) as important determinants of SMW policy. Comparative European research also highlights the importance of partisanship while showing that strong unions may oppose SMWs because they view them as an inferior alternative to wage-setting through collective bargaining. Consequently, countries with strong unions have been less likely to adopt SMWs (Dingeldey et al. 2021; Picot 2023).

More recent case studies, mostly of the UK and Germany, attribute changes in union support for SMWs to declining bargaining power and a growing share of low-wage employment (Bosch 2018; Mabbett 2016; Marx and Starke 2017; Meardi and Seghezzi 2025; Meyer 2016; Weishaupt 2018). Meyer (2016) and Meardi and Seghezzi (2025) argue that unions traditionally favour collective bargaining over SMWs because it binds members, can lead to better wage outcomes, and strengthens the position of organised labour. They may, however, revise these preferences when labour market deregulation weakens their bargaining power and makes it harder to restore it within the existing system. Consistent with this argument, Kozák and Picot (2025) show that declining bargaining coverage is a key determinant of SMW introduction in 33 OECD countries between 1960 and 2017. They also find that left-wing governments are more likely to introduce and increase SMWs.

This literature connects to the research on the knowledge economy. Several studies argue that the knowledge economy contributes to declining union power and bargaining coverage, as high-skilled workers have weaker incentives to unionise and employers benefit from international competition (Acemoglu et al. 2001; Baccaro and Howell 2017; Iversen and Soskice 2019). Existing case studies link SMW expansion to these transformations, including changes in union position, public discontent, and ideological mobilisation (Bosch 2018; Mabbett 2016; Marx and Starke 2017; Poje 2019; Weishaupt 2018; Wilson 2017). The next section brings these strands of literature together to develop expectations about this relationship.

## 2.3 The knowledge economy and statutory minimum wages

The relationship between knowledge-economy development and SMWs is not straightforward. The knowledge economy literature links labour-market polarisation and declining union power to weaker support for redistribution, while research on SMW politics points to a different possibility: the expansion of low-wage employment and declining bargaining coverage may instead generate political pressure for stronger wage regulation. SMWs can thus represent a response to some of the labour-market changes associated with the knowledge economy.

Marx and Starke (2017) express this countermovement argument most explicitly in a case study of Germany. They maintain that support for an SMW grew in response to the Agenda 2010 reforms, which reduced welfare spending and deregulated the labour market, with the explicit goal of expanding the low-wage service sector. A new left-wing party, *Die Linke*, emerged in opposition to the reforms, while within the centre-left SPD, which had itself pushed these reforms, calls to mitigate their effects grew louder (Dostal 2012; Marx and Starke 2017). Weishaupt (2018) adds that in both the UK and Germany, ethical concerns arising from the expansion of the low-wage sector also generated support for SMWs among conservative and left-wing parties. Even trade unions that primarily represented labour market insiders increasingly supported the protection of labour market outsiders. Bosch (2018) shows that unions actively sought to overcome internal divisions by emphasising their tradition of solidarity and developing a narrative that resonated with the public mood. Public support was so widespread that the German Trade Union Confederation (DGB) named its minimum wage campaign one of its most successful public campaigns in history (DGB 2025). Although Marx and Starke (2017) do not establish causality, they argue that the success of the DGB campaign and, ultimately, the introduction of the German SMW were contingent on broad societal opposition to labour market polarisation, deregulation, and rising income inequality. The German case thus illustrates how political responses to labour-market transformation can generate support for SMW introduction despite political and organisational divides.

Similar dynamics may also be relevant to subsequent SMW increases. Wilson (2017) provides comparative evidence from five liberal welfare states, including the UK, that the growing number of low-paid workers and rising public concern about poverty wages contributed to renewed political support for higher minimum wage floors. Similarly, the 2010 increase in the Slovenian SMW followed a union minimum wage campaign backed by broad public support (Poje 2019).

These studies suggest that the labour-market changes associated with knowledge-economy development can generate political pressure for stronger SMW regulation. Declining bargaining coverage can weaken established mechanisms of wage-setting and reduce union capacity to secure higher wages through collective bargaining. This may contribute to an expansion of low-wage employment and greater labour-market insecurity, which in turn can create demand for alternative forms of wage regulation. This demand may contribute both to the introduction of SMWs where they do not yet exist and to increases in existing SMW levels. We therefore expect knowledge-economy development to be associated with greater SMW presence and higher SMW levels.

**Hypothesis 1:** In European ACDs, knowledge-economy development is associated with higher presence and levels of SMWs.

The expectation of a positive overall relationship, however, does not imply that the knowledge-economy development is the same in all countries. This development does not result from technological determinism but from an interdependent process involving existing institutions,

political struggles, economic structures, and technological innovation (Turnbull 2026; Zysman and Breznitz 2012). This perspective is consistent with the comparative political economy (CPE) literature, which has long highlighted different models of democratic capitalism and distinct trajectories of institutional change (Esping-Andersen 1989; Hall and Soskice 2001; Thelen 2009, 2014). Recent CPE approaches show that these institutional differences persist among advanced capitalist democracies (Baccaro and Pontusson 2016; Baccaro et al. 2022; Beramendi et al. 2015; Hassel and Palier 2021, 2025). Although scholars disagree on the causes and key actors responsible for institutional change and variety in the knowledge economy (Benoit and Vlandas 2026), they share the view that technological change is influenced by country-specific institutional and political conditions. Knowledge-economy development is therefore expected to follow different trajectories in different countries.

These different trajectories can, in turn, have different consequences for economic and political outcomes. Several studies show, for example, that technological change contributes to rising inequality, but that institutions and organised labour can moderate this effect (Hope and Martelli 2019; Huber and Stephens 2024; Kristal and Cohen 2016). In fact, income inequality has increased to different degrees despite the widespread diffusion of ICT. Different knowledge-economy trajectories should then likewise have different implications for SMW outcomes and shape both SMW presence and subsequent development. We therefore expect the association between knowledge-economy development and SMW outcomes to vary between different knowledge-economy trajectories.

**Hypothesis 2:** In European ACDs, the association between knowledge-economy development and SMW presence and levels differs between different trajectories of knowledge-economy development.

Finally, we ask whether knowledge-economy development adds explanatory power beyond the factors traditionally emphasised in the SMW literature. Previous research suggests that institutional factors, particularly collective bargaining coverage, and political factors, such as left government ideology, are central to explaining SMW outcomes (Durocher 2019; Kozák and Picot 2025; Rueda 2008). We expect that knowledge-economy development provides additional explanatory power beyond these institutional and political factors, because differences in the extent and trajectory of knowledge-economy development may shape SMW outcomes in different ways.

**Hypothesis 3:** In European ACDs, knowledge-economy development provides additional explanatory power for variations in SMW outcomes beyond collective bargaining and political factors.

We test these hypotheses in the following chapters by examining whether knowledge-economy development is associated with the presence and levels of SMWs, whether these relationships differ between service-oriented and manufacturing-oriented knowledge-economy development, and how their explanatory contribution compares to that of other factors.

### 3 Data and methodological approach

#### 3.1 Data

For our analysis, we construct a novel dataset that combines multiple sources to capture proxies for the knowledge economy, SMW presence and levels, and control variables from the existing literature.

Our proxy for the knowledge economy is taken from Diessner et al. (2025), who construct a *Knowledge Economy Index* (KE index) covering 22 ACDs to measure the knowledge intensity of these economies. We use the KE index of the 21 European countries in their database and exclude the United States. The main index is based on six indicators capturing different dimensions of knowledge intensity: ICT investments, industrial robot adoption, patents, and three occupational skill measures.

Diessner et al. (2025) further derive two sub-indices that account for different knowledge-based trajectories, thus the ‘systematic variation in the ways in which national knowledge economies are organized’ (Diessner et al. 2025, 19). These distinctions are central to our argument because different forms of knowledge-based growth may generate different political and economic conditions for SMW politics. The first sub-dimension (KE1) is based on ICT, managers, and professionals. The second (KE2) consists of the indicators on robots, patents, technicians, and associate professionals. The first represents economies oriented toward high-value-added services, while the second reflects the digitalisation of manufacturing. Although these dimensions are not mutually exclusive, they allow us to distinguish between different models of knowledge-based development. Some countries score high on both, suggesting a more balanced knowledge economy, whereas others score low on both, indicating more limited development of knowledge-intensive capabilities. Following Diessner et al. (2025), we use these sub-indices to account for institutional variation in knowledge economy trajectories and to test our second hypothesis.

SMW presence is derived from ICTWSSv6.1 (Visser 2019), with corrections from Kozak and Picot (2025). We code SMW as a binary variable indicating whether countries have an SMW in a given year (SMW = 1) or not (SMW = 0). Table 1 provides an overview of countries that had an SMW throughout the analysis period, introduced it between 1995 and 2021, or were without an SMW during that period. SMW levels (either in real PPP terms or as the Kaitz index) are taken from the OECD employment database (2025a).

**Table 1. Overview SMW introduction**

|                                                        |                                                                                                                               |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Countries with an SMW throughout the analysis period   | Belgium, Czech Republic, Estonia, France, Greece, Latvia, Lithuania, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain |
| Countries that introduced an SMW between 1995 and 2021 | Germany (2015), Ireland (2000), United Kingdom (1999)                                                                         |
| Countries without an SMW during the analysis period    | Austria, Denmark, Finland, Italy, Sweden                                                                                      |

We further include variables used by Kozák and Picot (2025), particularly bargaining coverage and the strength of left-wing parties in government. To account more broadly for the organisation of collective bargaining, we additionally include union density, wage-setting coordination and mandatory extension mechanisms for collective agreements (from OECD/AIAS-ICTWSS 2.0, bargaining coverage data for Spain from version 1.1 (OECD 2025b)). We further account for

political party dynamics through left-party competition (measured as the presence of multiple left-wing parties in parliament), the share of right-wing parties (from the ParlGov 2024 Release (Döring and Manow 2024)), and the overall number of parliamentary parties (from the Comparative Political Dataset (Armingeon et al. 2025)).

Finally, we include two control variables capturing labour market conditions: unemployment rate and female employment rate, from AMECO (2025) and the OECD employment database (OECD 2025a), respectively. Table 2 provides an overview of all variable definitions. Additional information on data sources, completeness, and variable construction can be found in Appendices A and B.

**Table 2. Definition of variables**

| Variable                     | Definition                                                                                                                                                            |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SMW                          | Legislative presence of an SMW by country and year (1=yes, 0=no)                                                                                                      |
| SMW level PPP                | Level of hourly SMW relative to CPI in constant 2022 USD (PPP)                                                                                                        |
| SMW level Kaitz              | Level of hourly SMW relative to median wage (%)                                                                                                                       |
| KE index                     | Knowledge Economy Index: based on investment in ICT, patents, industrial robots, and employment share of managers, professionals, technicians (latent variable)       |
| KE index 1                   | Dimension 1 of the KE Index: based on ICT investment and employment share of managers and professionals – proxy for greater dependence on higher value-added services |
| KE index 2                   | Dimension 2 of the KE Index: based on patents, industrial robots, and employment share of technicians – proxy for digitalisation of manufacturing                     |
| Bargaining coverage          | Share of employees subject to a collective agreement                                                                                                                  |
| Union density                | Share of employees who are union members                                                                                                                              |
| Coordination of wage-setting | Level of wage bargaining coordination as a proxy for corporatism, varies between 1 (fragmented bargaining) and 5 (economy-wide bargaining)                            |
| Mandatory extensions         | Governmental capacity to extend collective agreements (1=yes, 0=no)                                                                                                   |
| Share left parties           | Share of left-wing parties (social democratic, socialist, or communist) in government (% of parliamentary seats)                                                      |
| Left competition             | Value = 1 if there is more than one left-wing party in parliament                                                                                                     |
| Share of right parties       | Share of right-wing parties in parliamentary seats                                                                                                                    |
| Number of parties            | Number of parties in parliament based on vote shares and measured by Laakso and Taagepera (1979)                                                                      |
| Unemployment rate            | Unemployment rate (%)                                                                                                                                                 |
| Female employment rate       | Employment rate of women (%)                                                                                                                                          |

Table 3 presents summary statistics for all variables of the analysis. The share of country-year observations with a statutory minimum wage is high, with just over 70 per cent of observations recording an SMW during the study period. SMW levels vary substantially, providing a heterogeneous measure for our empirical analysis. The KE indices are more difficult to interpret directly, as they are constructed as latent variables and therefore do not have an immediate scale.

The descriptive statistics show considerable variation in the variables capturing collective bargaining, political factors, and labour market indicators. Collective bargaining variables such as bargaining coverage and union density are highly dispersed, and wage coordination spans the full range. Approximately half of country-year pairs have a governmental mandatory extension in place. The political variables also show that the share and number of left and right parties can vary considerably. Finally, labour market outcomes vary widely, with unemployment ranging from two to almost 28 per cent and female employment from around 22 to 60 per cent.

**Table 3. Summary statistics**

| Variable               | Obs | Mean  | St Dev | Min   | Max    |
|------------------------|-----|-------|--------|-------|--------|
| SMW                    | 567 | 0.71  | 0.45   | 0.00  | 1.00   |
| SMW level PPP          | 403 | 8.54  | 4.24   | 1.29  | 15.67  |
| SMW level Kaitz        | 403 | 46.69 | 7.95   | 22.38 | 67.03  |
| KE index               | 567 | 4.54  | 1.05   | 2.20  | 7.67   |
| KE index 1             | 567 | 4.56  | 0.99   | 2.60  | 7.87   |
| KE index 2             | 567 | 1.26  | 0.35   | 0.42  | 2.17   |
| Bargaining coverage    | 567 | 67.37 | 28.59  | 8.50  | 100.00 |
| Union density          | 567 | 29.64 | 20.00  | 4.50  | 83.10  |
| Wage coordination      | 567 | 2.61  | 1.28   | 1.00  | 5.00   |
| Mandatory extension    | 567 | 0.49  | 0.50   | 0.00  | 1.00   |
| Left share             | 567 | 0.19  | 0.20   | 0.00  | 0.64   |
| Left competition       | 567 | 0.81  | 0.39   | 0.00  | 1.00   |
| Right share            | 567 | 0.05  | 0.08   | 0.00  | 0.38   |
| Number parties         | 567 | 5.43  | 1.80   | 2.63  | 10.97  |
| Unemployment rate      | 567 | 9.05  | 4.35   | 2.00  | 27.80  |
| Female employment rate | 567 | 46.95 | 6.87   | 21.85 | 59.95  |

Multicollinearity was assessed using pairwise correlations (Table C1 in Appendix C) and variance inflation factors (VIFs, Table C2 in Appendix C). The highest correlation among explanatory variables is between bargaining coverage and mandatory extension (0.71), reflecting their conceptual overlap. However, VIF values indicate no serious multicollinearity concerns, with mean VIFs ranging from 2.05 to 2.17 and maximum VIFs from 4.38 to 4.95.

### 3.2 Methodological approach

For the empirical analysis, we employ two complementary econometric approaches: first, to examine the role of the knowledge economy for SMW presence; and second, to analyse its role for SMW levels. We further add a random forest analysis to evaluate the relative predictive power of the knowledge economy vis-à-vis collective bargaining characteristics, political factors, and labour market indicators in explaining variation in SMW outcomes.

#### Model 1: SMW presence

For the analysis of the SMW presence, we use binary choice models and consider two alternative specifications. As a baseline, we estimate a pooled probit model with country-clustered standard errors and year fixed effects. This specification treats country-year observations as independent, conditional on the covariates, while controlling for common time shocks through year fixed effects. Standard errors are clustered at the country level to account for within-country correlation over time. This approach is relatively simple without strong assumptions about unobserved country heterogeneity. However, it does not account for time-invariant country-specific factors that may affect both SMW presence and the explanatory variables.

Second, we estimate a random effects probit model that accounts for unobserved country-specific heterogeneity. This model includes a country-level random intercept  $\alpha_i$ , which captures persistent, time-invariant differences between countries, such as institutions or political norms. This allows countries to have different baseline probabilities of having an SMW, rather than pooling all cross-country differences into the error term. The random effects approach provides a more structured

way of capturing cross-country variation. However, it is based on the stronger assumption that the random effects are uncorrelated with the included regressors.

More demanding panel estimators, such as fixed-effects probit or correlated random-effects (Mundlak–Chamberlain) models, are not feasible in our case because only three countries experience an SMW introduction during the observation period. The resulting lack of within-country variation prevents these models from converging. We therefore rely on pooled probit and random-effects probit specifications.

For the pooled probit with time fixed effects, we estimate:

$$Pr(SMW_{it} = 1 | KE_{it}, X_{it}) = F(\beta_1 KE_{it} + \beta_2 X_{it} + \delta_t)$$

The model specifies the probability that an SMW is in place in country  $i$  at time  $t$  as a function of the knowledge economy and a set of control variables.  $F(\cdot)$  is the standard normal cumulative distribution function.  $KE_{it}$  captures the knowledge economy variable of interest,  $X_{it}$  the control variables, and  $\delta_t$  common time effects. The coefficient  $\beta_1$  captures the association between the knowledge economy and the probability of SMW presence, conditional on controls.

For the random effects probit model, we estimate:

$$Pr(SMW_{it} = 1 | \alpha_i) = F(\beta_1 KE_{it} + \beta_2 X_{it} + \delta_t + \alpha_i)$$

This model accounts for unobserved, time-invariant country heterogeneity. In addition to  $KE_{it}$ ,  $X_{it}$ , and  $\delta_t$ , the model includes a country-specific random intercept  $\alpha_i$ , which captures persistent differences between countries that are not directly observed but could affect the likelihood of SMW presence.

## Model 2: SMW levels

For the analysis of SMW levels, we employ panel data models with country and time fixed effects. This specification focuses on variation in the SMW levels between countries and over time. We consider two dependent variables: SMW expressed in purchasing power parity (PPP) terms (in constant 2022 USD) and the Kaitz index, which measures the minimum wage relative to the median wage.

The baseline specification is estimated using a fixed effects panel model:

$$SMWLevel_{it} = \beta_1 KE_{it} + \beta_2 X_{it} + \alpha_i + \gamma_t + \varepsilon_{it}$$

where  $SMWLevel_{it}$  denotes the level of the SMW in country  $i$  at time  $t$ .  $KE_{it}$  represents the knowledge economy variable of interest,  $X_{it}$  the control variables,  $\alpha_i$  country fixed effects,  $\gamma_t$  year fixed effects, and  $\varepsilon_{it}$  the error term. By accounting for both country and year fixed effects, the fixed-effects estimator isolates the association between changes in the knowledge economy and changes in SMW levels within countries over time.

## Model 3: Random forests

To complement the regression analysis, we employ a random forest approach to assess the relative predictive importance of the knowledge economy vis-à-vis collective bargaining, political, and labour market factors for SMW presence and levels. While the regression models estimate the relationship between individual explanatory variables and SMW outcomes, random forests provide an additional perspective on the predictive contribution of competing explanations without imposing a specific functional form.

Random forests are machine learning models based on a combination of decision trees. Each tree is estimated using a random subset of observations and explanatory variables, and the final prediction is obtained by averaging across all trees (continuous outcomes) or by majority voting (binary outcomes). This approach allows the model to capture complex relationships, interactions, and nonlinear effects.

For our analysis, we use classification forests for the binary SMW presence variable and regression forests for the continuous SMW level measures. All random forest models are estimated with 500 trees. Model performance is evaluated using out-of-bag (OOB) error, while variable importance measures are used to assess the relative importance of predictors for SMW outcomes.

The random forest models are estimated on the pooled country-year dataset and therefore do not explicitly model the panel structure of the data. The variable importance measures thus reflect both cross-country differences and within-country variation over time.

For the SMW presence analysis, the random forest model predicts the probability that a country-year observation has an SMW in place based on all explanatory variables:

$$\begin{aligned} \mathbf{SMWPresence}_{it} \\ = f(\mathbf{KE}_{it}, \mathbf{CollectiveBargaining}_{it}, \mathbf{Political}_{it}, \mathbf{LabourMarket}_{it}) + \epsilon_{it} \end{aligned}$$

where  $\mathbf{SMWPresence}_{it}$  indicates whether a SMW exists in country  $i$  at time  $t$ . The set of predictors includes the control variables as before. The model is evaluated based on its predictive accuracy, while variable importance measures are used to identify which factors contribute most to predicting SMW presence.

For the SMW level analysis, the random forest model predicts the SMW level using the same set of explanatory variables:

$$\mathbf{SMWLevel}_{it} = f(\mathbf{KE}_{it}, \mathbf{CollectiveBargaining}_{it}, \mathbf{Political}_{it}, \mathbf{LabourMarket}_{it}) + \epsilon_{it}$$

where  $\mathbf{SMWLevel}_{it}$  represents the SMW level expressed either in PPP terms or relative to median wages through the Kaitz index. Variable importance scores are then used to rank the relative contribution of different predictors in explaining variation in SMW levels.

The random forest analysis provides an additional perspective on whether knowledge economy characteristics emerge as important predictors of SMW outcomes relative to collective bargaining, political, and labour market factors.

## 4 Results

### 4.1 SMW presence

Table 4a reports the pooled probit regressions, showing that the knowledge economy proxies have varying effects on SMW presence. The KE main index has a significant negative effect on SMW presence, suggesting that the more developed the knowledge economy, the lower the likelihood that a country has an SMW. This finding holds when controlling for collective bargaining as well as for government party composition, two key drivers of SMW adoption (Kozák and Picot 2025).

The two sub-indices of the KE index show opposing effects. KE1, indicating greater dependence on higher value-added services, shows a positive correlation but is not statistically significant. The second dimension, reflecting more digitalized and automated manufacturing, is significantly and

negatively correlated with SMW presence. Thus, the overall negative effect of the main index seems to be driven by the properties of the second sub-index.

**Table 4a. Pooled probit (average marginal effects)**

|                        | (1)<br>SMW            | (2)<br>SMW            | (3)<br>SMW            |
|------------------------|-----------------------|-----------------------|-----------------------|
| KE index               | -0.2688***<br>(-5.08) |                       |                       |
| KE index 1             |                       | 0.0086<br>(0.38)      |                       |
| KE index 2             |                       |                       | -0.9530***<br>(-7.74) |
| Bargaining coverage    | -0.0007<br>(-0.85)    | -0.0073***<br>(-2.68) | -0.0019***<br>(-2.60) |
| Union density          | -0.0120***<br>(-5.51) | -0.0096***<br>(-4.80) | -0.0259***<br>(-8.17) |
| Wage coordination      | -0.0835***<br>(-3.23) | -0.0419**<br>(-2.18)  | -0.0881***<br>(-5.78) |
| Mandatory extension    | 0.0053<br>(0.17)      | 0.3654***<br>(3.72)   | 0.2196***<br>(9.83)   |
| Left share             | -0.0879**<br>(-2.44)  | -0.0473<br>(-0.69)    | -0.0449**<br>(-2.05)  |
| Left competition       | 0.1018***<br>(3.16)   | 0.0127<br>(0.16)      | 0.0555**<br>(2.50)    |
| Right share            | 0.0471<br>(0.29)      | -0.6230<br>(-1.56)    | -1.6789***<br>(-8.01) |
| Number of parties      | 0.1464***<br>(4.54)   | 0.0754***<br>(4.45)   | 0.2809***<br>(7.70)   |
| Unemployment rate      | 0.0097***<br>(4.93)   | 0.0130**<br>(2.40)    | 0.0307***<br>(9.18)   |
| Female employment rate | 0.0274***<br>(5.95)   | 0.0107*<br>(1.69)     | 0.0436***<br>(7.04)   |
| Observations           | 567                   | 567                   | 567                   |

Table 4b reports the random effects models that further account for unobserved country-specific heterogeneity. The results show that this alternative model largely supports the previous finding, suggesting that, as before, the KE2 is significantly and negatively correlated with SMW presence. The overall KE index, although again negative, is no longer significant.

The results indicate that the knowledge economy plays a different role in explaining SMW presence in Europe. While the service-oriented dimension of the knowledge economy (KE1) is not significantly associated with SMW presence, the manufacturing-oriented dimension (KE2) is significantly and negatively associated with it. The smaller coefficient of KE2 in the random effects model shows that this relationship is mainly related to differences between countries rather than within-country changes over time. Overall, these findings show that the relationship between the knowledge economy and SMW presence depends on the trajectory of knowledge-based development and not simply on the overall level of knowledge-economy development.

The results of our control variables mostly support the findings established in the SMW literature. Bargaining coverage, union density, and wage coordination are mostly negatively and significantly correlated with SMWs in both models, consistent with previous research showing that strong collective bargaining can reduce demand for SMWs (Meardi and Seghezzi 2025; Meyer 2016; Kozák and Picot 2025). Mandatory extensions have a significant and positive effect in both models.

This may indicate that countries with established institutional mechanisms to compensate for low collective bargaining coverage are more likely to adopt SMWs as an additional measure to protect low-wage workers. The effect of left-leaning governments is significant only in the probit model, while left competition and the number of parties are positively correlated with SMWs in both models. The only economic control variable that has a significant effect is female employment, which is positive. Since women are often overrepresented in low-wage jobs, this could indicate stronger voter demand for SMWs.

**Table 4b. Random effects model (average marginal effects)**

|                        | (1)<br>SMW           | (2)<br>SMW            | (3)<br>SMW            |
|------------------------|----------------------|-----------------------|-----------------------|
| KE index               | -0.0358<br>(-0.85)   |                       |                       |
| KE index 1             |                      | 0.0144<br>(0.79)      |                       |
| KE index 2             |                      |                       | -0.1445*<br>(-1.79)   |
| Bargaining coverage    | -0.0025<br>(-1.24)   | -0.0033**<br>(-2.32)  | -0.0011<br>(-0.90)    |
| Union density          | -0.0087**<br>(-2.16) | -0.0070***<br>(-4.46) | -0.0090***<br>(-2.90) |
| Wage coordination      | -0.0403*<br>(-1.71)  | -0.0372***<br>(-3.14) | -0.0227<br>(-0.95)    |
| Mandatory extension    | 0.2247**<br>(2.28)   | 0.2212***<br>(2.77)   | 0.2185***<br>(3.04)   |
| Left share             | 0.0280<br>(0.76)     | 0.0291<br>(0.86)      | 0.0533<br>(1.34)      |
| Left competition       | 0.1200**<br>(2.14)   | 0.0311<br>(0.54)      | 0.0214<br>(0.36)      |
| Right share            | -0.1707<br>(-0.58)   | 0.0544<br>(0.27)      | 0.0688<br>(0.32)      |
| Number of parties      | 0.0384**<br>(2.17)   | 0.0240**<br>(2.31)    | 0.0420**<br>(2.14)    |
| Unemployment rate      | -0.0010<br>(-0.29)   | -0.0055<br>(-1.17)    | -0.0026<br>(-0.51)    |
| Female employment rate | 0.0108**<br>(2.07)   | 0.0017<br>(0.48)      | 0.0144***<br>(2.73)   |
| Observations           | 567                  | 567                   | 567                   |

## 4.2 SMW levels

We next analyse SMW levels for countries and years with an SMW in place. In Table 5a, which measures SMW levels in PPP-adjusted 2022 USD, the KE index is negative but not statistically significant. Once we disaggregate the KE index into its sub-indices, we again obtain opposite effects. KE1 is negatively associated with SMW levels, whereas KE2 is positively associated, although only the former relationship is statistically significant.

In Table 5b, we use the alternative measure (Kaitz), which captures the hourly SMW relative to the median wage in per cent. In that specification, the KE1 is again negative and significant, and the KE2 is positive and this time significant at 1 per cent. The overall KE index remains insignificant, suggesting that the effects of KE1 and KE2 offset each other.

**Table 5a. Panel data analysis – PPP**

|                        | (1)<br>SMW level PPP   | (2)<br>SMW level PPP   | (3)<br>SMW level PPP   |
|------------------------|------------------------|------------------------|------------------------|
| KE index               | -0.0807<br>(0.1823)    |                        |                        |
| KE index 1             |                        | -0.3030**<br>(0.1360)  |                        |
| KE index 2             |                        |                        | 0.3789<br>(0.3578)     |
| Bargaining coverage    | 0.0350***<br>(0.0049)  | 0.0369***<br>(0.0047)  | 0.0334***<br>(0.0046)  |
| Union density          | -0.0948***<br>(0.0102) | -0.0934***<br>(0.0102) | -0.0940***<br>(0.0102) |
| Wage coordination      | -0.0235<br>(0.0473)    | -0.0323<br>(0.0471)    | -0.0270<br>(0.0473)    |
| Mandatory extension    | -0.1638<br>(0.2167)    | -0.1570<br>(0.2153)    | -0.1657<br>(0.2164)    |
| Left share             | 0.1774<br>(0.1866)     | 0.1662<br>(0.1854)     | 0.1729<br>(0.1864)     |
| Left competition       | 0.4694***<br>(0.1276)  | 0.4822***<br>(0.1269)  | 0.4855***<br>(0.1285)  |
| Right share            | 2.1189**<br>(0.8290)   | 1.9431**<br>(0.8242)   | 2.2278***<br>(0.8254)  |
| Number of parties      | -0.2215***<br>(0.0364) | -0.2280***<br>(0.0355) | -0.2347***<br>(0.0368) |
| Unemployment rate      | -0.0366**<br>(0.0150)  | -0.0322**<br>(0.0150)  | -0.0384**<br>(0.0150)  |
| Female employment rate | 0.0214<br>(0.0191)     | 0.0253<br>(0.0191)     | 0.0232<br>(0.0192)     |
| Constant               | 16.7491***<br>(1.0333) | 17.3261***<br>(0.9508) | 16.1235***<br>(0.9558) |
| Observations           | 403                    | 403                    | 403                    |

These results suggest that European countries where high-value-added services are central to the economy tend to have lower SMW levels. By contrast, economies with more advanced manufacturing sectors sustain relatively higher SMW levels compared to median wages. However, countries without an SMW are excluded from this analysis; these are mostly characterised by strong and inclusive collective bargaining institutions. The economic types captured by the KE index and its sub-dimensions may therefore differ from those included in the analysis of SMW presence, possibly underrepresenting more egalitarian institutional settings.

Several control variables show significant associations with SMW levels. Union density is negatively correlated in both models, suggesting that union strength matters for both SMW presence and levels. Stronger unions may prioritise collective bargaining outcomes over increases in SMW levels (Grimshaw and Johnson 2024). The positive effect of the share of left-wing parties is significant only in the Kaitz model. Given the prominent role of left-wing parties in previous studies (Durocher 2019; Kozák and Picot 2025; Rueda 2008), this finding points to a more limited effect. The number of parties is significantly and negatively correlated in both models. While more parties increase the likelihood of SMWs, they may hinder subsequent increases by making agreement on higher levels more difficult. Finally, unemployment has a consistently negative effect, supporting the assumption that governments hesitate to increase SMWs during periods of high unemployment (Kozák and Picot 2025; Zavodny 2020).

**Table 5b. Panel data analysis – Kaitz index**

|                        | (1)<br>SMW level Kaitz | (2)<br>SMW level Kaitz | (3)<br>SMW level Kaitz |
|------------------------|------------------------|------------------------|------------------------|
| KE index               | 0.6588<br>(1.0198)     |                        |                        |
| KE index 1             |                        | -1.6669**<br>(0.7611)  |                        |
| KE index 2             |                        |                        | 8.6823***<br>(1.9507)  |
| Bargaining coverage    | 0.0254<br>(0.0276)     | 0.0478*<br>(0.0261)    | 0.0158<br>(0.0250)     |
| Union density          | -0.3348***<br>(0.0572) | -0.3270***<br>(0.0570) | -0.3162***<br>(0.0559) |
| Wage coordination      | 0.2262<br>(0.2643)     | 0.1656<br>(0.2636)     | 0.1191<br>(0.2580)     |
| Mandatory extension    | 1.2645<br>(1.2121)     | 1.2992<br>(1.2047)     | 1.2144<br>(1.1799)     |
| Left share             | 3.4270***<br>(1.0440)  | 3.3363***<br>(1.0377)  | 3.2572***<br>(1.0165)  |
| Left competition       | 0.8965<br>(0.7139)     | 0.9928<br>(0.7100)     | 1.3239*<br>(0.7007)    |
| Right share            | -4.9686<br>(4.6369)    | -6.4883<br>(4.6123)    | -3.7297<br>(4.5001)    |
| Number of parties      | -0.6203***<br>(0.2039) | -0.6106***<br>(0.1984) | -0.8202***<br>(0.2008) |
| Unemployment rate      | -0.1675**<br>(0.0841)  | -0.1358<br>(0.0842)    | -0.1917**<br>(0.0819)  |
| Female employment rate | -0.2970***<br>(0.1069) | -0.2767***<br>(0.1067) | -0.2582**<br>(0.1044)  |
| Constant               | 79.6737***<br>(5.7795) | 86.0876***<br>(5.3213) | 72.7047***<br>(5.2110) |
| Observations           | 403                    | 403                    | 403                    |

### 4.3 Random forests

To complement the regression analysis, we apply random forest models to assess the relative importance of the knowledge economy vis-à-vis collective bargaining, political, and labour market factors. This approach identifies the predictors that contribute most to explaining the variation in SMW presence and levels.

Table 6 shows that the random forest models are able to predict SMW presence quite well for the knowledge economy proxies. The OOB error rates are low in all specifications (0.009), indicating that the models can distinguish well between observations with and without an SMW. Because the random forest models are estimated on the pooled country-year dataset, this predictive performance reflects both differences between countries and changes within countries over time. The specification using the overall KE index provides the best predictive performance, although the differences between the three KE measures are small.

The importance rankings further show that the KE measures are the most important predictors in all three models (the complete variable importance rankings are reported in Appendix D). In each specification, the respective KE measure receives the highest relative importance score. This suggests that differences in knowledge-economy development contain relevant information for

predicting whether countries have an SMW. The consistency of this finding using the three alternative KE measures indicates that the relationship is not dependent on the KE proxy.

**Table 6. Random forest model – SMW presence**

| Model | KE Measure | OOB Error | Relative importance | Rank (out of 11) |
|-------|------------|-----------|---------------------|------------------|
| RF1   | KE index   | 0.009     | 1.000               | 1                |
| RF2   | KE index 1 | 0.009     | 1.000               | 1                |
| RF3   | KE index 2 | 0.009     | 1.000               | 1                |

These results should not be interpreted as contradicting the regression analysis. While the regression models estimate the association between individual KE measures and SMW presence, the random forest analysis assesses their overall contribution to prediction. The strong predictive performance of the KE measures thus suggests that knowledge-economy development is highly informative for explaining variation in SMW presence.

Table 7 presents the random forest results for SMW levels using the PPP-adjusted and Kaitz measures. Compared with the models predicting SMW presence, the SMW level models exhibit higher out-of-bag prediction errors, indicating weaker predictive performance for the continuous SMW outcome. For the PPP measure, the model using the KE1 performs best (OOB error = 0.650), followed by the overall KE index (0.661) and the KE2 (0.716). For the Kaitz measure, the differences in predictive performance are smaller, with OOB errors ranging from 2.014 to 2.049 in the three specifications.

**Table 7. Random forest model – SMW level (PPP and Kaitz)**

|              | Model | KE Measure | OOB Error | Relative importance | Rank (out of 11) |
|--------------|-------|------------|-----------|---------------------|------------------|
| <b>PPP</b>   | RF1   | KE index   | 0.661     | 1.000               | 1                |
|              | RF2   | KE index 1 | 0.650     | 0.627               | 2                |
|              | RF3   | KE index 2 | 0.716     | 0.294               | 4                |
| <b>Kaitz</b> | RF1   | KE index   | 2.014     | 0.200               | 6                |
|              | RF2   | KE index 1 | 2.049     | 0.215               | 5                |
|              | RF3   | KE index 2 | 2.031     | 0.253               | 3                |

The importance rankings show that the KE measures remain important predictors when SMW levels are measured using the PPP indicator. This pattern is weaker when using the Kaitz index, where the KE measures rank somewhat lower in terms of relative importance.

Overall, the results indicate that the predictive relevance of KE measures varies by measurement approach and SMW outcome. The KE measures are among the most important factors in predicting SMW presence and remain highly informative for SMW levels measured by the PPP indicator. Their lower relative importance in the Kaitz models points to more uncertainty in predicting this measure of SMW levels. These differences suggest that the role of the knowledge economy is more pronounced for the extensive margin of SMW adoption and for some measures of its level than for others.

## 4.4 Discussion

Our findings indicate that different forms of knowledge-economy development are associated with different SMW outcomes. While the KE index is mostly non-significant, its two sub-dimensions show significant and opposing relationships. A service-oriented development of the knowledge economy is positively, but not significantly, associated with SMW presence, whereas it is significantly and negatively associated with SMW levels. By contrast, the digitalisation of manufacturing is significantly and negatively associated with SMW presence, but positively associated with SMW levels once minimum wages are in place. This latter relationship is significant for one measure of SMW levels.

Based on the existing literature, it was *a priori* unclear whether the knowledge economy would drive or hinder the presence and level increases of SMWs. Research on the knowledge economy suggests that the growth of high-skilled employment may weaken support for redistribution and social protection (Iversen and Soskice 2019; Hope and Limberg 2022; Wren and Rehm 2014). By contrast, studies in Germany and the UK describe SMWs as a countermovement against labour market deregulation, expanding low-wage employment, and rising inequality (Bosch 2018; Marx and Starke 2017; Weishaupt 2018; Wilson 2017). Our findings suggest that the relationship depends on the type of knowledge-economy development. The five negative and significant correlations between the KE variables and SMW presence and levels align with the inequality/high-skilled-employment argument (Iversen and Soskice 2019; Häusermann et al. 2022; Hope and Limberg 2022; Wren and Rehm 2014). Meanwhile, the positive and significant correlation between SMW levels and KE2 presents the only support for the countermovement perspective.

For SMW presence, we find a negative association with KE2 (digitalization of manufacturing), which may be explained by the literature on export-led growth strategies and labour market dualization. Proponents of the dualization thesis argue that employers and labour market insiders have an interest in maintaining a precarious low-wage sector to remain competitive in international markets (Emmenegger et al. 2012; Hassel 2014; Rueda 2007; Thelen 2014). From a growth strategy perspective, states that depend on the export of manufactured goods are expected to pursue wage moderation, especially for labour market outsiders with less bargaining power, due to global price competition (Baccaro and Pontusson 2016; Hassel and Palier 2021, 2025). Diessner et al. (2022) specifically refer to the knowledge economy and contend that businesses in advanced manufacturing sectors depend on high-skilled employees for their ICT-intensive production and research and development. Employers thus aim to cut labour costs for less-skilled employees and use the saved resources to compete effectively for university graduates. As the KE2 represents knowledge-based growth driven by advanced manufacturing, its negative association with SMW presence is consistent with these expectations.

For SMW levels, we find a significant negative association between KE1 (higher value-added services) and SMW levels. Sample composition may partly explain this result. Several highly knowledge-intensive and service-intensive Scandinavian countries do not have an SMW and are therefore excluded. As a result, liberal market economies (LMEs) (Hall and Soskice 2001) become more prominent among countries with high KE1 values. LMEs are generally associated with higher levels of inequality, weaker protection for low-wage service workers, and higher levels of financialization (Esping-Andersen 1989; Iversen and Wren 1998). Financialised growth strategies are often linked to welfare-state retrenchment and the expansion of low-wage service employment (Hassel and Palier 2021; van der Zwan 2014). At the same time, governments following

financialised growth strategies may support minimum wages as a basic form of income protection to prop domestic demand, but at levels that do not substantially increase costs in service employment (Avlijaš et al. 2021). Furthermore, voters may be less supportive of redistribution due to high investment in private pension funds, a high homeownership rate, and a high employment share in the financial sector (Beramendi et al. 2015). The negative association between KE1 and SMW levels is therefore consistent with the view that highly financialised service-based knowledge economies may be less supportive of redistributive labour market policies.

The only evidence supporting the countermovement argument (Bosch 2018; Marx and Starke 2017; Weishaupt 2018; Wilson 2017) is the positive association between KE2 and SMW levels. However, the evidence is limited, as the relationship is significant only when using the Kaitz index. One possible interpretation is that export-oriented ACDs are less likely to adopt SMWs because of competitive pressures and labour market dualization. Once SMWs are adopted, however, they may be set at higher levels because they result from a broader political response to labour market changes and rising inequality. Given the limited robustness of the finding, this interpretation should be treated with caution.

Overall, these findings are broadly consistent with CPE approaches that assume persistent institutional variety in growth strategies and institutional arrangements (Baccaro and Pontusson 2016; Baccaro et al. 2022; Beramendi et al. 2015; Hassel and Palier 2021, 2025). In particular, the results point to different dynamics in service-based knowledge economies and export-oriented manufacturing economies.

The random forest analysis complements the regression results by showing that knowledge-economy variables rank among the most important predictors of SMW presence and levels. This finding reinforces the argument that knowledge-economy characteristics are important for understanding SMW outcomes alongside collective bargaining, political, and labour market factors. While most of the existing literature focuses on individual determinants of SMWs (Durocher 2019; Kozák and Picot 2025; Rueda 2008) or on specific country cases (Bosch 2018; Grimshaw and Johnson 2024; Mabbett 2016; Marx and Starke 2017; Meardi and Seghezzi 2025; Meyer 2016; Poje 2019; Weishaupt 2018; Wilson 2017), our findings suggest that broader patterns of knowledge-economy development also deserve attention.

Our results provide mixed support for our theoretical expectations. Hypothesis 1 is not supported, as the overall degree of knowledge-economy development is only weakly associated with SMW presence and levels. By contrast, Hypothesis 2 is supported, as the results consistently show that the two knowledge-economy trajectories are associated with different SMW outcomes. Hypothesis 3 is also supported. While institutional and political factors remain important predictors of SMW outcomes, knowledge-economy variables provide additional explanatory power and rank among the strongest predictors in the random forest analysis. The robustness analyses reported in Appendix E provide further support for these conclusions, as the main patterns remain largely unchanged in alternative specifications.

CPE studies that place the emergence of the knowledge economy centre stage rarely consider labour market policies such as SMWs (Baccaro and Pontusson 2016; Baccaro et al. 2022; Beramendi et al. 2015; Iversen and Soskice 2019; Hassel and Palier 2021, 2025). Our findings suggest that CPE can contribute to a better understanding of minimum-wage politics. In this sense, our study responds to Picot's (2025) call to reconnect labour market policy and CPE.

## 5 Conclusion

This paper analysed the relationship between the knowledge economy and SMW presence and levels in 21 European countries between 1995 and 2021. Our findings indicate that this relationship depends on the trajectory of knowledge-based growth. While the overall KE index is only weakly related to SMW outcomes, its two sub-dimensions show significant relationships in different directions. Service-oriented knowledge-economy development is associated with lower SMW levels, whereas manufacturing-oriented development is associated with lower SMW presence but, in some specifications, higher SMW levels once minimum wages are in place. Knowledge-economy variables also emerge among the strongest predictors of SMW outcomes. Overall, the findings suggest that different knowledge-economy developments are associated with different minimum-wage outcomes and that the knowledge-economy development is an important predictor of SMW outcomes.

Some limitations should be acknowledged. First, the analysis is based on a restricted sample of European countries and a limited number of SMW introductions, limiting our understanding of SMW dynamics. The SMW level analysis, in turn, is restricted to countries with SMWs in place. Second, although the sub-dimensions of the KE index capture important distinctions between knowledge-based trajectories, they cannot fully account for the institutional variety in advanced economies. As a proxy, it captures broad patterns of knowledge-economy development but not, directly, the institutional and political characteristics that distinguish different growth trajectories. Third, the analysis identifies associations rather than causal effects. The observational nature of the data does not allow us to establish whether knowledge-economy development causes particular SMW outcomes or whether both reflect broader underlying developments.

Future research could differentiate more clearly between social and labour market policies and examine whether assumptions about welfare state reform in the knowledge economy (e.g. Avlijaš et al. 2021) apply similarly to both. Arguably, pre-distributive labour market policies such as SMWs may follow different dynamics than more traditional redistributive policies, a distinction that has received relatively little attention in recent CPE research (Broska et al. 2026; Wilson 2017). Furthermore, it seems promising to expand the case base for analysing the relationship between SMW politics and the knowledge economy. Wilson (2017) shows that the increase in the political salience of SMWs has taken hold across most Anglo-Saxon countries, which, except for the UK, are not part of our study. The US are of special interest, as several of its states raised their wage floors in the 2010s after long-term political debate and union campaigning. Whether the knowledge economy can help explain differences among US states has not yet been explored (Rolf 2016; Rose 2020; Schuller 2026). The knowledge economy index (Diessner et al. 2025) includes, to date, only the US and 21 European states. Currently, analysing further cases would have to rely on different knowledge economy proxies.

More generally, our findings suggest that the knowledge economy should not be treated as a uniform phenomenon in analyses of labour market policy. Different trajectories of knowledge-based development appear to create distinct political and economic conditions for SMW politics, highlighting the value of bringing labour market policies such as SMWs into CPE analyses.

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## Appendix A – Variable sources and completeness

**Table A1. Variable overview**

| Variable                     | Definition                                                                                                                                                                                                                                                                                                                                                          | Source                                                                          | Completeness<br>(n=567)                                                                                                                                                                 |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SMW                          | Legislative introduction of a SMW                                                                                                                                                                                                                                                                                                                                   | ICTWSSv6.1 2019 (Visser 2019) with corrections from Kozak and Picot 2025        | Complete                                                                                                                                                                                |
| SMW level PPP                | Level of the hourly SMW relative to the consumer price index in USD (PPP)                                                                                                                                                                                                                                                                                           | OECD Database                                                                   | 4 missing for countries with SMW (Estonia 1995-7, UK 1999)                                                                                                                              |
| SMW level Kaitz              | Level of the hourly SMW relative to the median wage in per cent                                                                                                                                                                                                                                                                                                     | OECD Database                                                                   | 19 missing for countries with SMW (Estonia 1995-8, Latvia, Lithuania 1995-6, Slovenia 1995-2004, UK 1999)                                                                               |
| KE index                     | Based on investment in ICT, patents, industrial robots, and the employment share of managers, professionals, and technicians; latent variable: not directly measurable, values inferred from other observed and measurable variables (the higher, the more knowledge intensity); concrete values with little meaning, but comparable over time and across countries | Knowledge Economy Index                                                         | 67 missing (all countries 2020-1, Poland, Portugal, Slovakia, Slovenia 1995-9)                                                                                                          |
| KE index1                    | Dimension 1 of the KE Index; based on ICT investment and employment share of managers and professionals                                                                                                                                                                                                                                                             | Knowledge Economy Index                                                         | Same as KE index                                                                                                                                                                        |
| KE index2                    | Dimension 2 of the KE Index; based on patents, industrial robots, and employment share of technicians                                                                                                                                                                                                                                                               | Knowledge Economy Index                                                         | Same as KE index                                                                                                                                                                        |
| Bargaining coverage          | Share of employees subject to a collective agreement                                                                                                                                                                                                                                                                                                                | OECD/AIAS-ICTWSS_v2 (missing observations for Spain from OECD/AIAS-ICTWSS v1.1) | Latest update of database: 267 missing                                                                                                                                                  |
| Union density                | Share of employees who are union members                                                                                                                                                                                                                                                                                                                            | OECD/AIAS-ICTWSS_v2                                                             | Latest update of database: 80 missing                                                                                                                                                   |
| Coordination of wage-setting | Level of wage bargaining coordination as a proxy for corporatism, varies between 1 (fragmented bargaining) and 5 (economy-wide bargaining)                                                                                                                                                                                                                          | OECD/AIAS-ICTWSS_v2                                                             | 42 missing (all countries 2020-1)                                                                                                                                                       |
| Mandatory extensions         | Governmental capacity to extend collective agreements. 1 if mandatory extensions exist, 0 if not (coded after Kozak and Picot)                                                                                                                                                                                                                                      | OECD/AIAS-ICTWSS_v2                                                             | 42 missing (all countries 2020-1)                                                                                                                                                       |
| Share of leftist parties     | Left-wing parties (social democratic, socialist, or communist) in government: share of parliamentary seats out of all government parties                                                                                                                                                                                                                            | ParlGov 2024 Release                                                            | Complete                                                                                                                                                                                |
| Left competition             | Value 1 if there is more than one left-wing party in parliament                                                                                                                                                                                                                                                                                                     | ParlGov 2024 Release                                                            | Complete                                                                                                                                                                                |
| Share of right-wing parties  | Share of right-wing parties in parliamentary seats                                                                                                                                                                                                                                                                                                                  | ParlGov 2024 Release                                                            | Complete                                                                                                                                                                                |
| Number of parties            | Number of parties in parliament based on vote shares and measured by the Laakso and Taagepera (1979) formula                                                                                                                                                                                                                                                        | Comparative Political Dataset                                                   | Complete                                                                                                                                                                                |
| Unemployment rate            | Unemployed share of active population                                                                                                                                                                                                                                                                                                                               | AMECO                                                                           | Complete                                                                                                                                                                                |
| Female employment rate       | Employment share of female working age population (>15 years)                                                                                                                                                                                                                                                                                                       | OECD Database                                                                   | 101 missing (all countries except UK 1995-7, all countries except Czech Republic, Finland, Greece, Italy, Portugal and UK 1998, and 26 more missing across various countries and years) |

## Appendix B – Data preparation

**Table B1. Data preparation overview**

| <b>Variables</b>                                                                           | <b>Transformation</b>                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SMW level PPP, SMW level Kaitz                                                             | Linear extrapolation                                                                                                                                                                                                                                                                                                                                              |
| KE index, KE index 1, KE index2                                                            | Linear extrapolation                                                                                                                                                                                                                                                                                                                                              |
| Bargaining coverage                                                                        | We use the latest data release for all countries, except Spain, for which we use the previous release because the latest version contains many missing observations. Remaining missing values are completed using two extrapolation methods:<br>(1) Linear extrapolation (used in the analysis)<br>(2) Last observation carried forward (LOCF) (robustness check) |
| Union density                                                                              | We use the latest data release for all countries. Missing values are completed using two extrapolation methods:<br>(1) Linear extrapolation (used in the analysis)<br>(2) Last observation carried forward (robustness check)                                                                                                                                     |
| Wage coordination, Mandatory extensions                                                    | Last observation carried forward for years 2020-1 with value of 2019                                                                                                                                                                                                                                                                                              |
| Share of leftist parties, Left competition, Share of right-wing parties, Number of parties | Complete                                                                                                                                                                                                                                                                                                                                                          |
| Unemployment rate                                                                          | Complete                                                                                                                                                                                                                                                                                                                                                          |
| Female unemployment rate                                                                   | Linear extrapolation                                                                                                                                                                                                                                                                                                                                              |

## Appendix C – Variable correlation and VIF

**Table C1. Pairwise correlation**

| Variables                | (1)    | (2)    | (3)    | (4)    | (5)    | (6)    | (7)    | (8)    | (9)    | (10)   | (11)   | (12)   | (13)   | (14)   | (15)   | (16)  |
|--------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| (1) SMW                  | 1.000  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |       |
| (2) SMW Level (PPP)      |        | 1.000  |        |        |        |        |        |        |        |        |        |        |        |        |        |       |
| (3) SMW Level (Kaitz)    |        | 0.475  | 1.000  |        |        |        |        |        |        |        |        |        |        |        |        |       |
| (4) KE index             | -0.482 | 0.722  | 0.327  | 1.000  |        |        |        |        |        |        |        |        |        |        |        |       |
| (5) KE index 1           | -0.208 | 0.607  | 0.258  | 0.736  | 1.000  |        |        |        |        |        |        |        |        |        |        |       |
| (6) KE index 2           | -0.456 | 0.411  | 0.228  | 0.802  | 0.229  | 1.000  |        |        |        |        |        |        |        |        |        |       |
| (7) Bargaining coverage  | -0.420 | 0.513  | 0.358  | 0.322  | 0.034  | 0.317  | 1.000  |        |        |        |        |        |        |        |        |       |
| (8) Union density        | -0.624 | 0.183  | -0.086 | 0.347  | 0.334  | 0.177  | 0.454  | 1.000  |        |        |        |        |        |        |        |       |
| (9) Wage coordination    | -0.555 | 0.558  | 0.115  | 0.493  | 0.279  | 0.388  | 0.573  | 0.518  | 1.000  |        |        |        |        |        |        |       |
| (10) Mandatory extension | -0.009 | 0.453  | 0.407  | 0.000  | -0.214 | 0.103  | 0.709  | 0.047  | 0.270  | 1.000  |        |        |        |        |        |       |
| (11) Left share          | -0.067 | 0.054  | 0.166  | -0.061 | -0.107 | -0.038 | 0.152  | 0.073  | 0.056  | 0.138  | 1.000  |        |        |        |        |       |
| (12) Left competition    | 0.013  | 0.361  | -0.004 | 0.097  | 0.213  | -0.067 | 0.189  | 0.188  | 0.123  | 0.014  | 0.168  | 1.000  |        |        |        |       |
| (13) Right share         | -0.245 | 0.028  | -0.104 | 0.245  | 0.024  | 0.295  | 0.118  | 0.113  | 0.218  | 0.063  | -0.104 | -0.373 | 1.000  |        |        |       |
| (14) Number of parties   | 0.140  | 0.102  | 0.025  | 0.223  | 0.157  | 0.240  | -0.015 | 0.140  | 0.001  | 0.044  | -0.170 | -0.024 | 0.296  | 1.000  |        |       |
| (15) Unemployment        | 0.210  | -0.307 | -0.195 | -0.460 | -0.344 | -0.356 | -0.178 | -0.171 | -0.323 | 0.056  | 0.034  | 0.052  | -0.123 | -0.045 | 1.000  |       |
| (16) Female employment   | -0.153 | 0.229  | 0.137  | 0.546  | 0.610  | 0.298  | -0.047 | 0.264  | 0.212  | -0.282 | -0.040 | -0.002 | 0.085  | 0.054  | -0.591 | 1.000 |

**Table C2. Variance inflation factor**

| Model | KE measure | Mean VIF | Maximum VIF |
|-------|------------|----------|-------------|
| 1     | KE index   | 2.17     | 4.95        |
| 2     | KE index 1 | 2.15     | 4.38        |
| 3     | KE index 2 | 2.05     | 4.68        |

## Appendix D – Random forests

**Table D1. Complete ranking – SMW**

| Model | Variable             | Importance   | Rank     |
|-------|----------------------|--------------|----------|
| RF1   | <b>KE index</b>      | <b>1.000</b> | <b>1</b> |
|       | Bargaining coverage  | 0.898        | 2        |
|       | Union density        | 0.879        | 3        |
|       | Wage coordination    | 0.823        | 4        |
|       | Mandatory extensions | 0.791        | 5        |
|       | Number of parties    | 0.774        | 6        |
|       | Right share          | 0.737        | 7        |
|       | Female employment    | 0.734        | 8        |
|       | Left competition     | 0.734        | 9        |
|       | Unemployment         | 0.724        | 10       |
|       | Left share           | 0.657        | 11       |
| RF2   | <b>KE index 1</b>    | <b>1.000</b> | <b>1</b> |
|       | Bargaining coverage  | 0.989        | 2        |
|       | Union density        | 0.865        | 3        |
|       | Left competition     | 0.849        | 4        |
|       | Wage coordination    | 0.841        | 5        |
|       | Mandatory extensions | 0.830        | 6        |
|       | Number of parties    | 0.778        | 7        |
|       | Right share          | 0.773        | 8        |
|       | Unemployment         | 0.771        | 9        |
|       | Female employment    | 0.696        | 10       |
|       | Left share           | 0.673        | 11       |
| RF3   | <b>KE index 2</b>    | <b>1.000</b> | <b>1</b> |
|       | Union density        | 0.949        | 2        |
|       | Bargaining coverage  | 0.936        | 3        |
|       | Wage coordination    | 0.837        | 4        |
|       | Left competition     | 0.820        | 5        |
|       | Mandatory extensions | 0.796        | 6        |
|       | Unemployment         | 0.776        | 7        |
|       | Number of parties    | 0.745        | 8        |
|       | Right share          | 0.741        | 9        |
|       | Female employment    | 0.735        | 10       |
|       | Left share           | 0.615        | 11       |

**Table D2. Complete ranking – SMW level (PPP)**

| Model | Variable             | Importance   | Rank     |
|-------|----------------------|--------------|----------|
| RF4   | <b>KE index</b>      | <b>1.000</b> | <b>1</b> |
|       | Mandatory extensions | 0.901        | 2        |
|       | Wage coordination    | 0.688        | 3        |
|       | Bargaining coverage  | 0.485        | 4        |
|       | Left competition     | 0.377        | 5        |
|       | Female employment    | 0.334        | 6        |
|       | Number of parties    | 0.284        | 7        |
|       | Unemployment         | 0.266        | 8        |
|       | Right share          | 0.253        | 9        |
|       | Union density        | 0.239        | 10       |
|       | Left share           | 0.111        | 11       |
| RF5   | Mandatory extensions | 1.000        | 1        |
|       | <b>KE index 1</b>    | <b>0.627</b> | <b>2</b> |
|       | Wage coordination    | 0.545        | 3        |
|       | Bargaining coverage  | 0.418        | 4        |
|       | Left competition     | 0.401        | 5        |
|       | Female employment    | 0.274        | 6        |
|       | Number of parties    | 0.227        | 7        |
|       | Unemployment         | 0.226        | 8        |
|       | Right share          | 0.219        | 9        |
|       | Union density        | 0.209        | 10       |
|       | Left share           | 0.094        | 11       |
| RF6   | Mandatory extensions | 1.000        | 1        |
|       | Wage coordination    | 0.637        | 2        |
|       | Bargaining coverage  | 0.358        | 3        |
|       | <b>KE index 2</b>    | <b>0.294</b> | <b>4</b> |
|       | Female employment    | 0.285        | 5        |
|       | Left competition     | 0.258        | 6        |
|       | Unemployment         | 0.217        | 7        |
|       | Number of parties    | 0.211        | 8        |
|       | Right share          | 0.205        | 9        |
|       | Union density        | 0.180        | 10       |
|       | Left share           | 0.082        | 11       |

**Table D3. Complete ranking – SMW level (Kaitz)**

| Model | Variable             | Importance   | Rank     |
|-------|----------------------|--------------|----------|
| RF7   | Mandatory extensions | 1.000        | 1        |
|       | Bargaining coverage  | 0.344        | 2        |
|       | Union density        | 0.215        | 3        |
|       | Wage coordination    | 0.211        | 4        |
|       | Female employment    | 0.202        | 5        |
|       | <b>KE index</b>      | <b>0.200</b> | <b>6</b> |
|       | Unemployment         | 0.164        | 7        |
|       | Right share          | 0.163        | 8        |
|       | Left competition     | 0.157        | 9        |
|       | Number of parties    | 0.126        | 10       |
|       | Left share           | 0.122        | 11       |
| RF8   | Mandatory extensions | 1.000        | 1        |
|       | Bargaining coverage  | 0.360        | 2        |
|       | Wage coordination    | 0.254        | 3        |
|       | Union density        | 0.244        | 4        |
|       | <b>KE index 1</b>    | <b>0.215</b> | <b>5</b> |
|       | Female employment    | 0.194        | 6        |
|       | Unemployment         | 0.175        | 7        |
|       | Right share          | 0.161        | 8        |
|       | Left share           | 0.145        | 9        |
|       | Number of parties    | 0.145        | 10       |
|       | Left competition     | 0.140        | 11       |
| RF9   | Mandatory extensions | 1.000        | 1        |
|       | Bargaining coverage  | 0.418        | 2        |
|       | <b>KE index 2</b>    | <b>0.253</b> | <b>3</b> |
|       | Wage coordination    | 0.251        | 4        |
|       | Female employment    | 0.240        | 5        |
|       | Union density        | 0.238        | 6        |
|       | Unemployment         | 0.193        | 7        |
|       | Number of parties    | 0.161        | 8        |
|       | Right share          | 0.154        | 9        |
|       | Left competition     | 0.154        | 10       |
|       | Left share           | 0.143        | 11       |

## Appendix E – Robustness

**Table E1. Alternative specifications**

|          | Baseline specification |         |          |
|----------|------------------------|---------|----------|
|          | KE                     | KE1     | KE2      |
| Presence | neg, ***               | pos, NS | neg, *** |
|          | neg, NS                | pos, NS | neg, **  |
| Levels   | neg, NS                | neg, ** | pos, NS  |
|          | pos, NS                | neg, ** | pos, *** |

|          | Extend  |         |          |
|----------|---------|---------|----------|
|          | KE      | KE1     | KE2      |
| Presence | neg, *  | pos, NS | neg, NS  |
|          | neg, NS | pos, NS | neg, NS  |
| Levels   | pos, NS | neg, NS | pos, *   |
|          | pos, NS | neg, ** | pos, *** |

|          | Extrapolate (excl. mandatory extensions) |         |          |
|----------|------------------------------------------|---------|----------|
|          | KE                                       | KE1     | KE2      |
| Presence | neg, ***                                 | neg, NS | neg, *** |
|          | neg, NS                                  | pos, NS | neg, NS  |
| Levels   | pos, NS                                  | neg, NS | pos, NS  |
|          | pos, NS                                  | neg, ** | pos, *** |

|          | Extrapolate (excl. mandatory extensions + female employment) |         |          |
|----------|--------------------------------------------------------------|---------|----------|
|          | KE                                                           | KE1     | KE2      |
| Presence | neg, ***                                                     | pos, NS | neg, *** |
|          | pos, NS                                                      | pos, NS | neg, NS  |
| Levels   | pos, NS                                                      | neg, NS | pos, *   |
|          | pos, NS                                                      | neg, ** | pos, *** |