Assessing the Impact of Minimum Wages on Employment in the European Union between 2000 and 2019: A Panel Data Analysis

Nathaniel Kieran Spedding

Professional Economist BSc and Apprenticeship Level 6

School of Economics

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Abstract

This dissertation examines the relationship between minimum wages and employment in 18 European Union countries between 2000 and 2019. Despite decades of debate, there is a lack of consensus in both the theoretical and empirical evidence as to whether minimum wages have negative employment effects. Whilst minimum wages are an important tool for governments to use to reduce wage inequality and increase low pay, it is important to recognise any adverse effects they may have. This dissertation tests three hypotheses: that the minimum wage has a statistically significant negative effect on the working-age employment rate, the teenage employment rate, and the low-skilled employment rate. This paper finds that there is no statistically significant impact of minimum wages on the working-age or low-skilled employment rate. However, the results do suggest there is a negative statistically significant impact of minimum wages on the teenage employment rate. Specifically, a percentage increase in the minimum wage decreases the teenage employment rate by 0.5%.

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1.

Introduction

The Resolution Foundation (2024, para. 1) recently proclaimed that "The introduction of the minimum wage in the UK in 1999 is the single most successful economic policy in a generation" and that it had raised the pay of millions of the lowest earners by £6,000 a year. Despite this, the debate around the impact of the minimum wage on employment has continued. Decades of research have failed to settle the debate, with no clear consensus on whether minimum wages have negative employment effects. This dissertation aims to contribute to the debate.

The minimum wage is defined as "the minimum amount of remuneration that an employer is required to pay wage earners for the work performed during a given period, which cannot be reduced by collective agreement or an individual contract" (International Labour Organization, 2014, p. 33). By 2013, over 160 countries around the world had a legally binding minimum wage (Dickens, 2023). Whilst minimum wages are an important policy tool for governments to use to try to reduce wage inequality and increase low pay, it is important to recognise any adverse effects they may have.

The way in which minimum wages are set by countries varies. In the United States, the federal government sets the minimum wage, whereas in Austria they are set by collective bargaining. Some countries, such as the United Kingdom, rely on an external expert body to either set or provide a recommendation of the minimum wage to the government (Dickens, 2023).

The treatment of younger workers with respect to the minimum wage differs between countries. Some countries, such as the United Kingdom, have a lower minimum wage rate for younger workers (Acas, 2024). The extent to which minimum wage rates for younger workers are discounted varies. A body of the minimum wage research focuses on the impact of minimum wages on younger workers, which this dissertation aims to contribute to.

This dissertation utilises econometric techniques to assess the relationship between minimum wages and employment in a panel of 18 European Union countries between 2010 and 2019. Specifically, this dissertation tests three hypotheses: that the minimum wage has a statistically significant negative effect on the working-age employment rate, the teenage employment rate, and the low-skilled employment rate.

The dissertation is structured as follows. Section 2 reviews the economic theory and existing empirical research. Section 3 outlines the data and variables used in the analysis undertaken. Section 4 explains the methodology and robustness of the analysis. Section 5 presents the results of the analysis. Section 6 draws together conclusions set against the original hypotheses of this dissertation.

2. Literature review

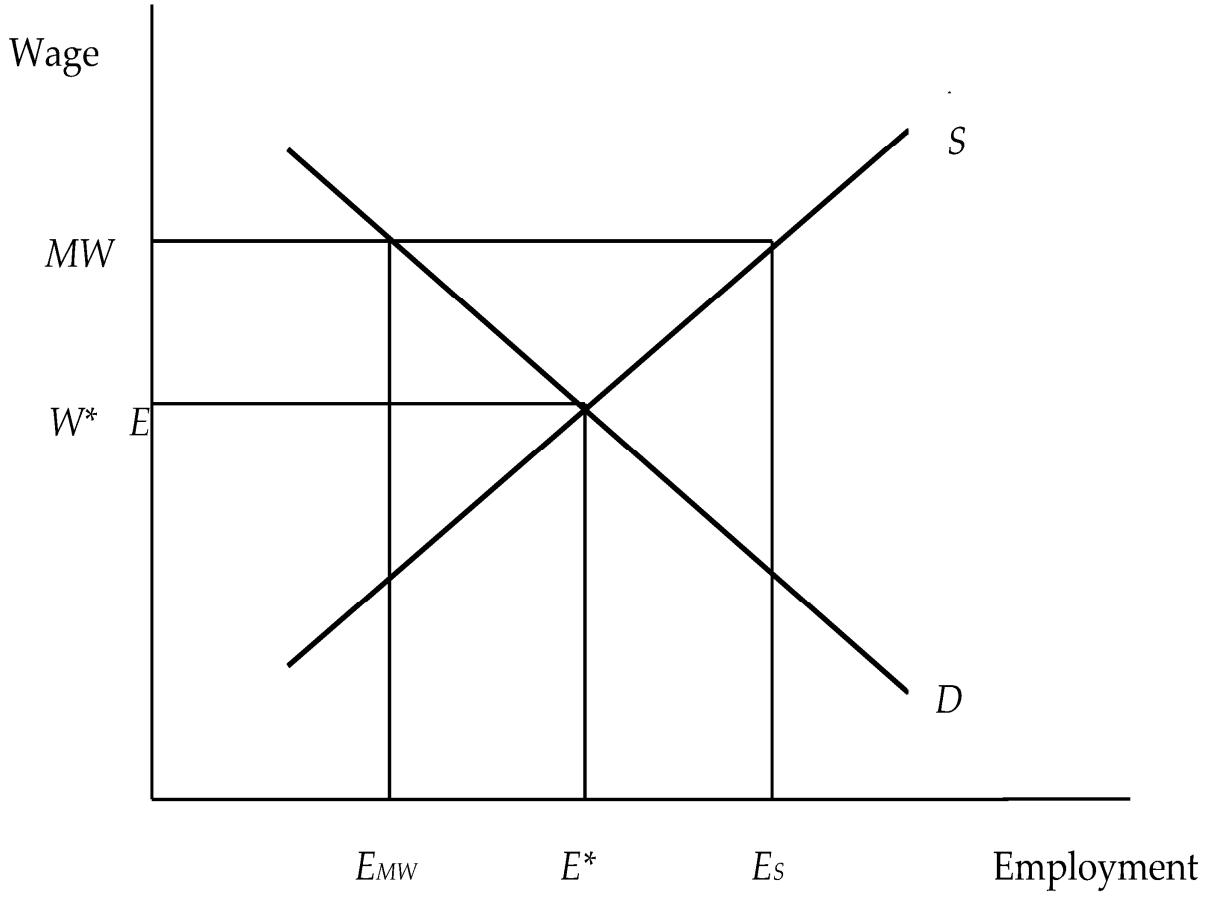
2.1 Economic theory

The effect of the minimum wage on employment is a contentious area of labour market economics that has been explored by economists for decades. As a result, various theoretical explanations have emerged. This section will briefly summarise several of the theoretical approaches and their predictions for the employment impacts of minimum wages.

2.1.1 Neoclassical approach

The neoclassical approach considers perfectly competitive labour markets, where employees and employers have the same bargaining power and as such are recipients of the market wage (*Figure 1*). They can neither lower nor raise it. Therefore, free market neoclassical economists see the minimum wage as an outside intervention which reduces the efficiency of the invisible hand (Brožová, 2018). Brzezinski (2017) describes how demand for labour decreases when the minimum wage (MW) is set above the initial market clearing wage (W*), reducing employment (from E* to E_{MW}).

Figure 1: The employment impact of minimum wages in the neoclassical approach (Giotis and Mylonas, 2022)



This may be due to firms substituting labour for other inputs, such as capital. Additionally, firms may substitute low-skilled workers for more skilled workers, which may temper the reduction in employment for low-skilled workers at the aggregate employment level (Neumark, 2014). As the effect may be more pronounced in low-skilled sectors, youth unemployment may increase as they can be more exposed to these sectors. Neumark and Wascher (2007) claim that their empirical research, part of which is summarised in section 2.2, supports the use of the neoclassical approach to describe and model changes in low-wage labour markets.

However, there are assumptions underpinning the neoclassical approach that may not hold true in the real world. It is assumed that workers are perfectly mobile and hold perfect information

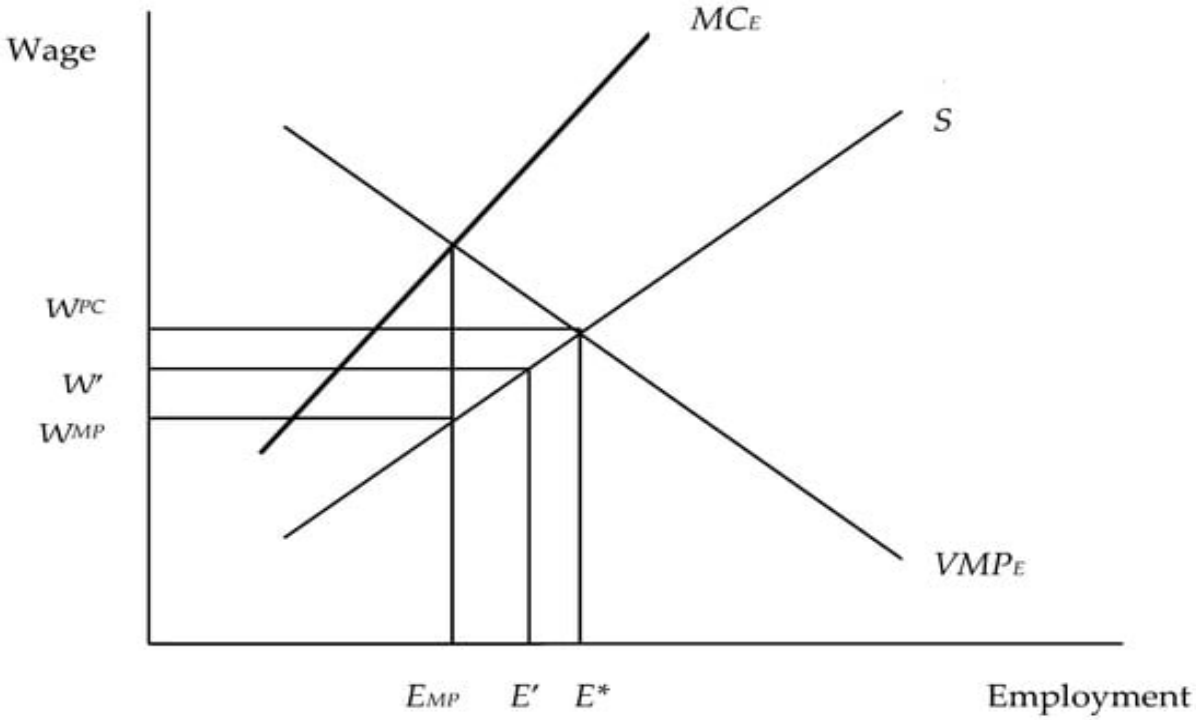
about wages in all firms, but this may not always hold true. It is also assumed that labour and capital are perfectly substitutable. Again, this may not always hold true (Herr, Kazandziska, and Mahnkopf-Praprotnik, 2009). Thus, it is uncertain how well the neoclassical approach can be applied to the real world.

2.1.2 Monopsony approach

In the monopsony model, a market in which employers have wage setting power is considered (*Figure* 2). Wages (W^{MP}) and number of employees (E_{MP}) are lower than in perfect competition (E* and W^{PC}) in the absence of a minimum wage. This is because wages are set below the competitive level by firms in a monopsonistic market as employers have some power in setting wages (Burdett and Mortensen, 1998; Neumark, 2014). Consequently, there is underemployment in a monopsony labour market.

However, the introduction of a minimum wage (W') increases employment (E') by limiting the bargaining power of employers (Manning, 2003). When the minimum wage is set at the level that would prevail in perfect competition, employment is maximised (Dolado et al., 1996). Dickens, Machin, and Manning (1999) argue that the empirical evidence is supportive of using the monopsony model to predict employment effects of minimum wages.

Figure 2: The employment impact of minimum wages in the monopsony model (Giotis and Mylonas, 2022)



2.1.3 Alternative theoretical approaches

The Keynesian approach summarises that an increase in the level of the minimum wage does not have a predetermined impact on employment. Whilst an increase in wages increases labour costs and is expected to increase prices, a direct relationship between changes in wages and employment does not exist (Herr and Kazandziska, 2011). Therefore, whilst minimum wages place upwards pressure on prices, their effect on employment is ambiguous (Giotis and Mylonas, 2022).

The efficiency wage theory offers an alternative framework, suggesting that higher minimum wages lead to increased productivity and efficiency. This offsets the higher labour costs that minimum wages may impose (Akerlof, 1982). Therefore, minimum wages set above the competitive market level can lead to increased employment.

Search and matching models explore how minimum wages influence the search effort and job matching of unemployed workers. Whilst increases in the minimum wage may reduce demand for labour, unemployed workers may search for work more intensely. As their search intensity increases, the quality of job matches may improve. If job matches are improved and offset the reduction in demand for labour, then job creation remains unchanged or increases. Therefore, the employment impact of minimum wages depends on whether improved job matches or reduced demand for labour is dominant (Meer and West, 2013).

A normative approach to minimum wages considers what minimum wages should be to ensure workers are compensated fairly. Considering imperfect competition in labour markets, Brožová (2018) describes that the distribution of rights and resources places workers in a dependent position and the employer in a dominant position. Consequently, wages and conditions are no longer protected by market competition, so minimum wages are required to improve equality and social justice. Therefore, this approach provides no clear prediction of the impact of the minimum wage on employment.

2.2 Empirical evidence

Empirical assessments of the impact of minimum wages on employment have been undertaken by economists for over a century. The debate has intensified since the new minimum wage research of the 1990's. Despite substantial research, economists are yet to form a definitive and unanimous conclusion. This section examines and summarises studies from the new minimum wage era and more recent research, which guides the methodology undertaken in this dissertation.

2.2.1 New minimum wage research

Neumark and Wascher dominated the early new minimum wage research alongside Card and Kruger in the United States. Katz and Krueger (1992) explored the employment impact of the 1991 federal minimum wage increase on Texas's fast-food industry. Looking at restaurants who were initially paying lower or higher wages and utilising the difference in employment changes between them, they reported a statistically significant positive impact on employment. This is in line with the predictions of the monopsony model. Similarly, Card and Krueger (1994) examined the impact of New Jersey's state minimum wage increase on employment in 410 fast-food restaurants. They instead utilised a difference-in-difference approach, failing to find a negative impact on employment. These initial results were inconsistent with the suggestions of the neoclassical approach.

On the other hand, Neumark and Wascher (1992) used a time and entity fixed effects approach on a panel of states from 1973 to 1989. They found a reduction in teenage employment of 1-2% in response to a 10% increase in the minimum wage. This was consistent with the suggestions of the neoclassical approach. However, Card, Katz, and Krueger (1994) examined the methodology of Neumark and Wascher (1992) and altered it in line with their own approach, producing results consistent with their previous work of no negative employment effects. Similarly, Neumark and Wascher (1995) revisited the work of Card and Krueger

(1994). Using payroll data instead of the original survey data they instead found negative employment effects.

During this period, evidence was beginning to emerge from countries outside the United States. Machin and Manning (1997) examined four European countries (France, Netherlands, Spain, and the United Kingdom) finding little evidence that minimum wages had a negative impact on employment. This was supported by the work of Dolado et al. (1996) which reported minimum wages only had negative employment effects on younger workers in Europe. Both papers identified the impact of minimum wages on employment by using regional variation in average wages.

However, in the United Kingdom, Minford, and Ashton (1996, cited in Machin and Manning, 1997) reported that minimum wages had large negative employment effects. Furthermore, Neumark and Wacher (1999) used a fixed effects approach on a panel of 16 OECD countries between 1975 and 1997 and reported negative employment effects for young workers. In New Zealand, Maloney (1995) found employment of young adults reduced by 3.5% in response to a 10% increase in the adult minimum wage rate, but the employment of teenagers increased by 6.9%. Chapple (1997) demonstrated that whilst it was possible to produce negative employment impacts from minimum wages in New Zealand, these results were subject to issues such as omitted variable bias.

2.2.2 More recent research

Meer and West (2013) utilise a fixed effects approach in their research into the effects of minimum wages on employment in the United States. Using the level of minimum wages and controls for labour demand and supply, they find statistically significant employment elasticities in the region of -0.15 to -0.20 in respect to minimum wages. They additionally utilise long-difference and distributed lag specifications as there is theoretical rationale for employment adjusting more slowly to changes in the minimum wage, which they argue is not often captured in the wider literature. These additional estimations also produce negative employment effects.

Arpaia et al. (2016) also use a fixed effects approach to explore the impacts of minimum wages on employment in the European Union. They examine the employment impacts on the working-age population, young adults, and low-skilled workers. They utilise employment rates and controls to reflect the wider economic environment, such as the prime-age male unemployment rate. Country and time fixed effects are also used to control for time-invariant trends across the European Union and differences between countries. They find the minimum wage has no statistically significant impact on the working-age and low-skilled employment rate but has a statistically significant negative impact on the youth employment rate.

Brzezinski (2017) uses an unbalanced panel of 19 OECD countries to investigate the impact of minimum wages on youth unemployment. They use the youth employment rate, the ratio of the minimum wage to median earnings and controls for demand. In contrast to the approach of Arpaia et al. (2016) the specification uses a lag of the minimum wages. A fixed effects approach is used to control for time-invariant factors that influence how different countries set their minimum wage. Their results indicate that minimum wages have a statistically significant negative effect on youth unemployment. They comment that the introduction of a suitable instrumental variable estimation would lend further credibility to results using fixed effect

approaches due to the potential for reverse causality between minimum wages and employment.

Rybczynski and Sen (2017) similarly use a fixed effects approach on panel data from Canadian provinces to investigate the employment effects of the minimum wage. They utilise controls variables such as average wages, to control for growth in average wages, and the prime-aged male unemployment rate and GDP, to control for regional economic cycles and labour market conditions. To control for unobserved policy shocks, regional and time fixed effects are employed. They report statistically significant reductions in employment for teenagers, but no statistically significant employment impacts for adults.

Pantea (2020) uses regional panel data in Romania from 2008 to 2016. Their specification utilises the employment rate, minimum wage to mean wage ratio and controls for local demand shocks. As is common, regional and time fixed effects are used to control for macroeconomic shocks and time-invariant regional characteristics. Using dynamic panel models, their results suggest that employment is not reduced by minimum wages.

2.2.3 Meta-analysis research

There have also been various meta-analysis conducted to ascertain the overall view of the literature on the employment impacts of minimum wages. Martínez and Jiménez (2020) review over 500 studies spanning over a century. They find that over 70% of the literature reports negative effects on employment, with an average elasticity of -0.06. Elasticities were lowest for time series approaches (-0.01) and highest for fixed effect and instrumental variable approaches (-0.08). Giotas and Mylonas (2022) summarise that whilst their research showed no negative employment effects of minimum wages, there remains an absence of a clear and definitive relationship in the literature and that negative relationships tend to be driven by more sensitive groups.

2.3 Summary and hypotheses

There is an absence of consensus in both the theory and empirical evidence as to the relationship between minimum wages and employment. In the theory, different approaches yield opposing predictions. The neoclassical approach predicts negative employment effects whilst the monopsony approach predicts positive employment effects. The results of the empirical research range when examining the working-age and low-skilled employment rates but yield more consistent findings of negative effects for the teenage employment rate. The existing empirical research does not comprehensively provide support to a singular theoretical framework.

Taking into consideration the range of predictions from the economic theory and empirical evidence, three hypotheses are tested:

1. The minimum wage has a statistically significant negative effect on the working-age employment rate.
2. The minimum wage has a statistically significant negative effect on the teenage employment rate.
3. The minimum wage has a statistically significant negative effect on the low-skilled employment rate.

3. Data

3.1. Panel details

To examine the hypotheses of this dissertation, a balanced panel of 18 European Union countries from 2000 to 2019 using annual data is constructed. The sample is limited to the 18 countries that had a minimum wage for all years between 2000 and 2019 to ensure a balanced panel. The countries included are: Belgium, Czech Republic, Estonia, France, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and the United Kingdom.

Whilst the United Kingdom is no longer a member of the European Union at the time of submission, the United Kingdom did not formally exit the European Union until January 2020. As the panel is from 2000 to 2019, the United Kingdom is included. The period does not extend beyond 2019 due to the pandemic, which may cause severe estimation issues.

The panel is balanced, with complete observations for each variable for all countries and years. The panel is constructed using data from the OECD and International Labour Organization. Where possible, data was quality assured against an alternate source. Panel data is selected, instead of time-series or cross-sectional data, as it improves the accuracy of the inference of model parameters (Hsiao, Mountain and Illman, 1995) and controls for the impact of omitted variables due to heterogeneity in the data (Baltagi, 2005). This improves the robustness of the inference of coefficients.

3.2 Dependent variables

In this dissertation, the impact of minimum wages on the working-age employment rate, the teenage employment rate and the low-skilled employment rate is estimated. They are the three dependent variables used. Employment measures of low-skilled and teenage workers are included, as their wages are more likely to be closer to the minimum wage (Orrenius and Zavodny, 2008). Therefore, they are more likely to suffer employment impacts from minimum wage rises relative to the entire working-age population.

3.3 Main independent variable

The main independent variable used is the level of the minimum wage. As outlined in the introduction, several countries set youth minimum wages below the full minimum wage. For simplicity and due to data constraints, this dissertation does not incorporate lower minimum wage rates for younger workers.

3.4 Other control variables

Other independent variables are used in this dissertation to control for wider economic conditions and reduce omitted variable bias. The prime-aged male unemployment rate and GDP per capita are used to control for economic cycles and regional labour market conditions (Neumark and Wascher, 1999; Rybczynski and Sen, 2017). If minimum wage increases are cyclical, then these controls for economic cycles will also reduce any endogeneity bias that occurs, as the estimated minimum wage coefficient would be biased upwards as wages would be expected to be increasing in a growing economy.

Average wages are used to control for growth in average wages (Orrenius and Zavodny, 2008; Addison, Blackburn and Cotti, 2014). Controlling for the average wage of other workers allows

the specification to control for the relative cost of the minimum wage to other workers. If the minimum wage increases relative to the average wage, then theory predicts firms will substitute workers creating larger negative employment effects. The final control variable is educational attainment (Dube, 2019; Nguyen, 2023). Controlling for educational attainment is important. Daly, Jackson, and Valletta (2007) find the labour forces composition changes due to higher educational attainment, moving towards groups with lower unemployment rates.

3.5 Variables functional form

All variables except the employment rate do not exhibit a normal distribution. Therefore, all variables are transformed into their natural logarithmic form to improve the normality of their distribution. This approach is used in the literature, with Orrenius and Zavodny (2008) and Sturn (2018) utilising a log-log specification to allow the estimated coefficients to be interpreted as elasticities. Natural logarithms are notated as ln.

Table 2: Variables

Variable	Description	Source
Working-age employment rate	The ratio of employed persons to the population in the 15-64 age group	OECD
Teenage employment rate	The ratio of employed persons to the population in the 15-19 age group	OECD
Low-skilled employment rate	The ratio of employed persons to the population of individuals whose highest level of education attainment was elementary education[1]	OECD
Minimum wage	The level of the minimum wage converted into US dollars using purchasing power parities	International Labour Organization
Prime-aged male unemployment rate	The unemployment rate of 25–54 year-old males	OECD
GDP per capita	GDP converted into US dollars using purchasing power parities divided by total population	OECD and International Labour Organization
Average wage	Average wages converted into US dollars using purchasing power parities	International Labour Organization
Educational attainment	The percentage of the 25-64 population whose highest educational attainment is tertiary education[2]	OECD

[1]Education attainment is internationally standardised through ISCED 2011 classifications. Elementary education is classed as early childhood, primary and lower secondary education. The use of this variable to measure the low-skilled employment rate mirrors the approach of Arpaia et al. (2016).

[2] Tertiary education provides learning activities in specialised fields of study that builds on secondary education. Tertiary education includes short-cycle tertiary education, Bachelor's, Master's, and doctoral and equivalents. (OECD, 2015)

3.6 Correlation between the employment rates and the minimum wage

Tests for correlation between the three employment rates and the minimum wage each report a value of +0.39. This suggests there is a weak positive relationship between the variables. However, "correlation does not imply causation" (Luca, M, 2021, para. 1). Thus, correlation between the variables does not mean that a change in one variable causes a change in the other. To robustly test for causal effects, we employ the econometric techniques that are outlined in section 4.

4. Methodology and robustness

4.1 The working-age employment model

This section sets out the process undertaken to arrive at the final model used to analyse the effect of minimum wages on working-age employment. To begin, a simple pooled OLS is run with the specification:

$$ln\_WorkingAgeEmploymentRate_{i,t} = \beta_0 + \beta_1 ln\_MinimumWage_{i,t} + \beta_2 ln\_PrimeAgedMaleUnemploymentRate_{i,t} + \beta_3 ln\_GDPpercapita_{i,t} + \beta_4 ln\_AverageWage_{i,t} + \beta_5 ln\_Education_{i,t} + \varepsilon_{i,t} \quad [1]$$

All variables are significant at the 90% confidence interval. Both the White's test for heteroskedasticity and Wooldridge test for autocorrelation report p-values below 0.05. As such, the null hypothesis that there is no heteroskedasticity or autocorrelation present is rejected. Hence, Arellano robust standard errors are used to control for autocorrelation and heteroskedasticity moving forward. This allows for the robust inference of coefficients. The RESET test for specification reports a p-value above 0.05. Thus, the null hypothesis that the specification is adequate is not rejected. This suggests that the base specification is not misspecified and the functional form is appropriate.

The next estimation is a fixed effects model. This allows fixed entity effects to be introduced to account for time-invariant individual heterogeneity and unobserved individual characteristics. An example of this, as highlighted in the introduction, is that the way in which minimum wages are set varies by country. Fixed effect approaches also help to mitigate against reverse causality. Entity fixed effects are commonly used in the literature (Addison and Ozturk, 2010; Totty, 2017; Allegretto et al., 2017). The specification becomes:

$$ln\_WorkingAgeEmploymentRate_{i,t} = \beta_0 + \beta_1 ln\_MinimumWage_{i,t} + \beta_2 ln\_PrimeAgedMaleUnemploymentRate_{i,t} + \beta_3 ln\_GDPpercapita_{i,t} + \beta_4 ln\_AverageWage_{i,t} + \beta_5 ln\_Education_{i,t} + \alpha_i + \varepsilon_{i,t} \quad [2]$$

Where α_i represents fixed entity effects. The explanatory power of the model is improved from 60% to 79%. The joint F test reports a p-value below 0.05, hence the null hypothesis is rejected. The fixed effects approach is preferable to OLS. The test for differing group intercepts reports a p-value below 0.05. Thus, the null hypothesis that groups have a common intercept is rejected. This lends further credibility to the fixed effects approach. A random effects model is trialled, but the Hausman test reports a p-value below 0.05. Thus, the null hypothesis that GLS estimates are consistent is rejected. The fixed effects approach is preferable to random effects.

Next, time fixed effects are introduced into the fixed effects model. Time fixed effects help to control for time-invariant trends and factors that may lead to biased results. Time fixed effects capture time factors, such as the economic cycle and shocks, which are common across countries. The use of time fixed effects is common in the literature (Neumark and Wascher, 1992; Allegretto, Dube and Reich, 2011; Paun et al., 2021). The specification becomes:

$$ln\_WorkingAgeEmploymentRate_{i,t} = \beta_0 + \beta_1 ln\_MinimumWage_{i,t} + \beta_2 ln\_PrimeAgedMaleUnemploymentRate_{i,t} + \beta_3 ln\_GDPpercapita_{i,t} + \beta_4 ln\_AverageWage_{i,t} + \beta_5 ln\_Education_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t} \quad [3]$$

Where λ_t represents fixed time effects. The explanatory power of the model improves from 79% to 83%. The joint F test reports a p-value below 0.05, hence the null hypothesis is rejected. The fixed effects approach remains preferable to OLS. The Wald test on time effects reports a p-value below 0.05. Hence, the null hypothesis that time effects are not present is rejected. The use of fixed time effects is valid. The Breusch-Pagan LM and Pesaran CD tests for cross-sectional dependence report p-values below 0.05. Thus, the null hypothesis that cross-sectional dependence is not present is rejected. Hence, the model is re-estimated using Driscoll and Kraay standard errors to control for cross-sectional dependence and allow for the robust inference of coefficients (Hoechle, 2007). Autocorrelation and Heteroskedasticity are also controlled for using Driscoll and Kraay standard errors (Vogelsang, 2012). This is the final model used to estimate the effect of minimum wages on working-age employment. The results are discussed in section 5.1.

4.2 The teenage and low-skilled employment model

The final entity and time fixed effects specification in the working-age employment model [3] is used to estimate the effects of the minimum wage on teenage employment:

$$ln\_TeenageEmploymentRate_{i,t} = \beta_0 + \beta_1 ln\_MinimumWage_{i,t} + \beta_2 ln\_PrimeAgedMaleUnemploymentRate_{i,t} + \beta_3 ln\_GDPpercapita_{i,t} + \beta_4 ln\_AverageWage_{i,t} + \beta_5 ln\_Education_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t} \quad [4]$$

Where α_i represents fixed entity effects and λ_t represents fixed time effects. This specification is also utilised to test the effects of the minimum wage on low-skilled employment:

$$ln\_LowSkilledEmploymentRate_{i,t} = \beta_0 + \beta_1 ln\_MinimumWage_{i,t} + \beta_2 ln\_PrimeAgedMaleUnemploymentRate_{i,t} + \beta_3 ln\_GDPpercapita_{i,t} + \beta_4 ln\_AverageWage_{i,t} + \beta_5 ln\_Education_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t} \quad [5]$$

Where α_i represents fixed entity effects and λ_t represents fixed time effects. Both the teenage and low-skilled employment rates are used in their natural logarithmic form as outlined in section 3.5. To arrive at the final specification of the teenage employment model [4] and low-skilled employment model [5], the methodology outlined to arrive at the final working-age employment model [3] in section 4.1 is followed. Arellano clustered standard errors are used to control for autocorrelation and heteroskedasticity present in the teenage employment model. The null hypothesis of no cross-sectional dependence is not rejected, so controls for cross-sectional dependence are not required. In the low-skilled employment model, Driscoll and Kraay standard errors are used to control for autocorrelation, heteroskedasticity and cross-sectional dependence. This is as the null hypothesis of no cross-sectional dependence is rejected

and autocorrelation and heteroskedasticity are present. The results of these models is discussed in sections 5.2 and 5.3.

4.3 Further tests for robustness

4.3.1 Unit root testing

Tests for stationarity are conducted using both Im–Pesaran–Shin and Levin–Lin–Chu unit root tests. The working-age employment rate, minimum wage, GDP per capita and Education variables report p-values above 0.05. Therefore, the null hypothesis of unit roots in the panels is not rejected. These variables are non-stationary. The low-skilled employment rate, teenage employment rate, average wage and prime-aged male unemployment rate all report p-values below 0.05. Therefore, the null hypothesis of unit roots in the panels is rejected. These variables are stationary and integrated of order zero.

The working-age employment rate, minimum wage, GDP per capita and Education are all integrated of order one. When first differenced, they report a p-value below 0.05 for both the Im–Pesaran–Shin and Levin–Lin–Chu unit root tests and the null hypothesis of unit roots in the panels are rejected. This means that if required, the first differences of the variables that exhibit non-stationarity can be used as first differencing them makes them stationary. However, first differencing removes long-term information from variables as they are transformed into their change over the period. This limits the information that can be inferenced from the variables about their relationships over time.

4.3.2 Tests for cointegration

The variables that are non-stationary have a mean or variance that varies over time and wander. Cointegration means that non-stationary variables wander together and there is a long-run equilibrium relationship between the variables. Cointegration of these variables is tested. Three tests for cointegration are performed: the Kao test, the Pedroni test and the Westerlund test. Tests for cointegration are first performed on all non-stationary variables. All the tests for cointegration report a p-value below 0.05. Thus, the null hypothesis of no cointegration is rejected. Therefore, all the panels are cointegrated. There is a long-run relationship between the variables. Next, tests for cointegration are ran amongst the non-stationary and stationary variables used in each specification. This is due to the fixed effects models [3], [4] and [5] using all variables, not just the non-stationary variables. Again, all tests for cointegration report a p-value below 0.05. Thus, the null hypothesis of no cointegration is rejected. A long-run relationship between the stationary and non-stationary variables exists.

As per Azizi (2017), the presence of cointegration between the variables means that regressions using the fixed effects approach are non-spurious. This is due to the error terms being stationary. Phillips and Moon (1999) suggest the estimators will be consistent with a normal limiting distribution. Therefore, due to cointegration between variables, the final entity and time fixed effects model uses the non-stationary variables in their natural logarithms.

For robustness, the final models are also performed with the log difference of the non-stationary variables. The statistical significance and signs of the coefficients are in line with the estimations of the final fixed effects models presented.

5. Results

As the specifications used are log-log, the estimated coefficients can be interpreted as elasticities. The interpretation of β_1 therefore is that a percentage change in X_1 is associated with a β_1 percentage change in Y holding all other variables in the model constant (Rutledge, 2018).

5.1 Working-age employment model results

Table 3: Results: Entity and time fixed effects model where the working-age employment rate is the dependent variable (Driscoll and Kraay standard errors)

Model outputs:			
Variable:	Coefficient:	p-value:	Statistical significance:
Constant	−1.521 (0.134)	0.000	***
Minimum wage	−0.029 (0.026)	0.288	
Prime-aged male unemployment rate	−0.083 (0.009)	0.000	***
GDP per capita	0.061 (0.018)	0.003	***
Average wage	0.043 (0.011)	0.001	***
Educational attainment	0.033 (0.009)	0.003	***
Key model statistics:			
LSDV R-squared	0.931		
Within R-squared	0.819		

Note: Statistical significance is indicated at the 90 percent (*), 95 percent (**) and 99 percent (***) confidence intervals. Standard errors are in parentheses.

The main independent variable, minimum wage, has no statistically significant impact on the working-age employment rate, reporting a p-value of 0.217. In any case, the elasticity of -0.029 would suggest a negligible impact. The statistical insignificance of minimum wages with respect to employment is not unusual in the literature. Belman and Wolfson (2010) and Rybczynski and Sen (2017) both utilise panel approaches and control variables similar to this dissertation. Whilst the geographical locations in these studies differ to this dissertation[3] they also produce statistically insignificant coefficients in the region of -0.05 to 0.05. It appears likely that the similarity in the approaches leads to consistent findings. Meta-analysis conducted by Martínez and Jiménez (2020) supports these findings, reporting an average employment elasticity of -0.04.

However, Meer and West (2013) argue that it is common for the literature, as in this dissertation, to assume employment adjusts rapidly to changes in the minimum wage. As a

[3] Belman and Wolfson (2010) use data in the United States between 1972 and 2001 whilst Rybczynski and Sen (2017) use Canadian provinces between 1981 to 2011.

result, they suggest that the lack of a significant relationship between minimum wages and employment has been interpreted as minimum wages having a minimal employment impact. Instead, they believe that the adjustment may be slower and utilising distributed lag specifications find a statistically significant total employment elasticity of -0.07 over three years with respect to the minimum wage. They therefore argue that the exclusion of lags of the minimum wage in the wider literature means that it has not focused on the longer-term employment impacts. This may provide insight as to why the results of this dissertation are statistically insignificant in comparison to their work.

To address this, up to three lag terms of the minimum wage are trialled in conjunction with and instead of the non-lag minimum wage. The minimum wage and its lag terms remain statistically insignificant. More dynamic models, such as those used by Meer and West (2013), could be used to investigate the longer-term relationship further.

All control variables are statistically significant at the 99% confidence interval. The prime-aged male unemployment rate has a negative relationship with the working-age employment rate. A percentage increase in the prime-aged male unemployment rate decreases the working-age employment rate by 0.08%. All other control variables, GDP per capita, average wages and educational attainment, have a positive relationship with the working-age employment rate. GDP per capita has the largest positive impact on the working-age employment rate, with a percentage increase associated with a 0.06% increase in the working-age employment rate. The R^2 of this model is 0.819, meaning that the models independent variables explain approximately 82% of the variability in the working-age employment rate.

5.2 Teenage employment model results

Table 4: Results: Entity and time fixed effects model where the teenage employment rate is the dependent variable (Arellano standard errors)

Model outputs:			
Variable:	Coefficient:	p-value:	Statistical significance:
Constant	−4.819 (2.336)	0.053	*
Minimum wage	−0.543 (0.159)	0.003	***
Prime-aged male unemployment rate	−0.341 (0.075)	0.000	***
GDP per capita	0.406 (0.242)	0.110	
Average wage	0.176 (0.123)	0.168	
Educational attainment	0.004 (0.209)	0.983	
Key model statistics:			
LSDV R-squared	0.926		
Within R-squared	0.531		

Note: Statistical significance is indicated at the 90 percent (*), 95 percent (**) and 99 percent (***) confidence intervals. Standard errors are in parentheses.

The main independent variable, minimum wage, is statistically significant at the 99% confidence interval. In contrast to the non-statistically significant impact on the working-age employment rate, minimum wages are found to have a statistically significant negative relationship with the teenage employment rate. A percentage increase in the minimum wage decreases the teenage employment rate by 0.54%.

This finding is supported by studies in the literature. Burkhauser, Couch, and Wittenburg (2000), Neumark and Wascher (2004) and Campolieti, Gunderson and Riddell (2006) all utilise panel approaches and control variables similar to this dissertation. Whilst the geographical and time periods examined differ[4], the studies all report statistically significant elasticities in the region of -0.2 to -0.6 for teenage employment. The similarity in panel approaches and control variables between these studies and this dissertation appear to result in similar results being obtained. Brzezinski (2017) utilises a different lagged specification of the minimum wage to allow for longer time effects and reports statistically significant elasticities in the region of -0.3. This suggests that the results may be robust to alternative specifications.

Of the control variables, only the prime-aged male unemployment rate is statistically significant. The prime-aged male unemployment rate is statistically significant at the 99% confidence interval and has a negative relationship with the teenage employment rate. A percentage increase in the prime-aged male unemployment rate correlates with a 0.34% reduction in the teenage employment rate. All other control variables, GDP per capita, average wages and educational attainment, are statistically insignificant. The R^2 of the model is 0.531, meaning that the independent variables in the model explain approximately 53% of the variability in the teenage employment rate.

5.3 Low-skilled employment model results

Table 5: Results: Entity and time fixed effects model where the low-skilled employment rate is the dependent variable (Driscoll and Kraay standard errors)

Model outputs:			
Variable:	Coefficient:	p-value:	Statistical significance:
Constant	3.254 (0.963)	0.004	***
Minimum wage	0.022 (0.076)	0.773	
Prime-aged male unemployment rate	−0.121 (0.031)	0.001	***
GDP per capita	−0.043 (0.112)	0.710	
Average wage	0.119 (0.055)	0.049	**
Educational attainment	−0.070 (0.099)	0.490	
Key model statistics:			
LSDV R-squared	0.913		
Within R-squared	0.534		

Note: Statistical significance is indicated at the 90 percent (*), 95 percent (**) and 99 percent (***) confidence intervals. Standard errors are in parentheses.

[4] Neumark and Wascher (2004) focus on OECD countries between 1975 and 2000 whilst Campolieti, Gunderson, and Riddell use a panel of Canadian provinces between 1981 and 1997.

The main independent variable, minimum wage, is shown to have no statistically significant impact on the low-skilled employment rate, reporting a p-value of 0.773. In any case, the elasticity of 0.02 suggests that minimum wages would have a negligible impact on the low-skilled employment rate.

This result is in line with other studies in the literature. Orrenius and Zavodny (2008) and Sturn (2018) use panel data and control variables similar to this dissertation, although employ different estimation techniques. Despite the differences in geographical location[5] and estimation techniques, the studies report statistically insignificant elasticities between 0.09 to -0.06. Arpaia et al. (2016) report statistically significant elasticities in the region of -0.2 for a restricted sample of European Union countries using a panel approach and set of control variables similar to this dissertation. However, once the restriction on countries are lifted and Latvia, Luxembourg and Romania are included as in this dissertation, the elasticities also become statistically insignificant. It appears that the similarity in control variables leads to consistent findings that appear relatively robust to alternative estimation techniques.

Of the control variables, only the prime-aged male unemployment rate and the average wage are statistically significant. The prime-aged male unemployment rate is found to be statistically significant at the 99% confidence interval and have a negative relationship with the low-skilled employment rate. A percentage increase in the prime-aged male unemployment rate decreases the low-skilled employment rate by 0.12%. Average wages are found to be statistically significant at the 95% confidence interval and have a positive relationship with the low-skilled employment rate. A percentage increase in average wages increases the low-skilled employment rate by 0.12%. The remaining control variables, GDP per capita and educational attainment, are statistically insignificant. The R^2 of this model is 0.534, meaning that the independent variables in this model explain approximately 53% of the variability in the low-skilled employment rate.

5.4 Sensitivity of the results to a change in the measure of the minimum wage

There are two common measures of the minimum wage used in the literature, the minimum wage level and the minimum wage to average wage ratio. This dissertation uses the minimum wage level in the specifications and results presented in sections 4 and 5. The use of the minimum wage to average wage ratio is trialled to examine the sensitivity of the results to the specification. As in Rybczynski and Sen (2017), the results are consistent across both measures of the minimum wage. The sign and statistical significance of the coefficients are unchanged.

6. Conclusion

This dissertation adds further evidence to the literature on the impact of minimum wages on employment by examining a panel of 18 countries in the European Union between 2000 and 2019. Specifically, this dissertation intended to explore the impact of minimum wages on employment using econometric techniques. Utilising an entity and time fixed effects model, the hypotheses set out in the introduction are tested.

[5] Orrenius and Zavodny (2008) focus on low-skilled workers in the United States between 1994 and 2005 whilst Sturn (2018) uses a panel of OECD countries between 1997 and 2013.

The first hypothesis tested is that minimum wages have a statistically significant negative effect on the working-age employment rate. This hypothesis is rejected, as this dissertation finds no statistically significant relationship between the minimum wage and the working-age employment rate. This is in line with the findings of Belman and Wolfson (2010), Arpaia et al. (2016), Rybczynski and Sen (2017) and Pantea (2020). Instead, control variables for the economic cycle, growth in average wages and educational attainment were found to have statistically significant effects on the working-age employment rate.

The second hypothesis tested is that minimum wages have a statistically significant negative effect on the teenage employment rate. This hypothesis is not rejected, as this dissertation finds a statistically significant negative effect of minimum wages on the teenage employment rate. This is in line with the findings of Burkhauser, Couch and Wittenburg (2000), Neumark and Wascher (2004), Campolieti, Gunderson and Riddell (2006), Allegretto, Dube and Reich (2011), and Rybczynski and Sen (2017). One of the economic cycle control variables, the prime-aged male unemployment rate, is found to have a statistically significant negative effect on the teenage employment rate.

The third and final hypothesis tested is that minimum wages have a statistically significant negative effect on the low-skilled employment rate. This hypothesis is rejected, as this dissertation finds no statistically significant negative effect of minimum wages on the low-skilled employment rate. This is in line with the findings of Orrenius and Zavodny (2008), Addison, Blackburn and Cotti (2014), Arpaia et al. (2016) and Sturn (2018). Two of the control variables are also found to be statistically significant. The prime-aged male unemployment rate, a control for economic cycles, is found to have a statistically significant negative effect on the low-skilled employment rate. Average wages are found to have a statistically significant positive effect on the low-skilled employment rate.

Linking the empirical findings from this dissertation to the economic theory, outlined in section 2.1, it is difficult to solely lend support to a singular theoretical prediction. On one hand, the negative relationship between the teenage employment rate and minimum wage is in line with the predictions of the neoclassical approach. However, this dissertation reports no statistical significance for the working-age and low-skilled employment rate, which perhaps aligns more closely with the Keynesian prediction of no direct relationship between wages and employment. This highlights the difficulty of applying theoretical predictions to the real world.

It should be noted that the results of this dissertation are caveated by the fixed effects model used in the presence of unit roots. However, all panels in this dissertation are cointegrated leading to non-spurious results (Azizi, 2017). Future research could utilise more specialised estimations such as Error Correction Models or Autoregressive Integrated Moving Average models, which would lend further credibility to the results of this dissertation and the literature.

Furthermore, it is suggested in the literature that the minimum wage may have a lagged effect on employment (Meer and West, 2013). Whilst this dissertation trialled the use of lags within the final fixed effects model and found no significant differences in the results obtained, future research could trial the use of specific autoregressive techniques such as Autoregressive Distributed Lag models to explore this further. Additionally, the suggestions of Brzezinski (2017) for further work into Instrumental Variable estimations appear sensible. Both approaches would lend further credibility to the results of the fixed effects approach in this dissertation and the literature.

Taking these limitations into account, the results suggest that minimum wages have no negative employment effects for working-age adults and low-skilled workers. However, this dissertation finds that minimum wages have negative effects on teenage employment. Policymakers should note that this dissertation makes no assessment of how high minimum wages, in particular relative to average wages, can be set before negative employment effects occur amongst working-age and low-skilled workers. A potential avenue for future research could be to explore this, perhaps with the aim of estimating an optimum level of the minimum wage relative to the average wage.

Finally, future research into the effects of minimum wages on teenage employment should, where applicable, look to include measures of the youth minimum wage as opposed to the adult minimum wage. Examining whether the teenage employment effect differs between estimations with the adult minimum wage compared to the youth minimum wage could lend further credibility to the results of this dissertation and the literature.

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