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A review of methods applied in international research on the employment effects of the minimum wage and implication for Australian research

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- Australian Industry Group (Ai Group);

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- Australian Council of Trade Unions (ACTU);

- Australian Government; and

- State and territory governments.

The contents of this report, however, remain the responsibility of the author and the research has been conducted without the involvement of members of the Fair Work Commission.

Table of contents

Executive summary

This report summarises the main empirical methods used in international research on the employment effects of the minimum wage. It is intended to provide a background for considering the potential for extra research on this topic in Australia.

Research on the employment effects of the minimum wage requires making a comparison between employment outcomes for workers who are and who are not affected by a change to the minimum wage. Being able to identify groups of workers who are and who are not affected by the minimum wage is therefore a necessary starting point for research on this topic.

The first main contribution of the report is to describe the methods used in the international research to identify workers who are and who are not affected by the minimum wage. International research on the employment effects of the minimum wage suggests a variety of potential methods that would be worthwhile to explore for application in Australia. These methods involve identifying groups of workers who are and are not affected by a change in the minimum wage on the basis of:

- Geographic location;

- Position in the distribution of wages;

- Occupation/industry/establishment; and

- Age.

Potential data sources with information on wages and employment outcomes for individual workers that could be investigated for undertaking this research include Australian Bureau of Statistics (ABS) data sources (such as the Labour Force Survey (LFS), Survey of Employee Earnings and Hours (EEH) and the Wage Price Index (WPI)); government administrative data; the Household, Income and Labour Dynamics in Australia (HILDA) Survey; and firm-level personnel records.

The second main contribution of the report is to describe issues that have been found in international research to affect the validity of empirical findings on the employment effects of the minimum wage. It is suggested that a check-list of issues to consider in planning research on this topic should include:

- For what group of workers should the analysis be undertaken?

- Can treatment and control groups be identified?

- What is the degree of compliance by employers with increases in the minimum wage?

- How should/can the employment outcome be represented?

    (i) What measure of employment—for example, persons employed or hours?

    (ii) Can the impact on hiring (job creation) be captured?

    (iii) How should the impact on employment be specified—for example, level or growth rate?

- How should differences in labour market conditions between the treatment and control groups be controlled for?

- What other explanatory variables for employment should be included?

- Are changes to the minimum wage exogenous to labour market conditions?

- What should be the time period for which the employment effect of a change in the minimum wage is examined?
- What method will be used to calculate standard errors?
- What approach will be taken to report the findings?
- How representative will the findings be?

1 Introduction

The minimum wage is an integral aspect of government regulation of labour markets in most industrialised countries. The level of the minimum wage is generally set by a government body that has been assigned responsibility for wage-setting or directly by politicians through a legislative process. The justification provided for the chosen level of the minimum wage is often cast in terms of a welfare trade-off: between the positive effects of a higher minimum wage on income distribution and the negative effects on employment. Understanding the employment effects of the minimum wage is therefore of vital importance for regulators and policy-makers, and consequently has been a major area of research for labour economists.

By now, there is an extensive international literature on this topic, and to this day it remains the subject of vigorous research activity (for surveys, see Brown et al., 1982; Brown, 1999; Manning, 2013, 2016; Neumark and Wascher, 2008; Belman and Wolfson, 2014; Hafner et al., 2016; Neumark, 2017). By comparison, the institutional setting and data constraints have meant that in Australia the set of empirical studies of the employment effects of the minimum wage is small, and most studies have commonly been regarded as limited in their contribution (for a review, see Productivity Commission, 2015a).

The objective of this report is to use the international empirical literature on the employment effects of the minimum wage to provide insights into whether there is potential for extra research on this topic in Australia and how that research might be undertaken.

Empirical analysis of the employment effects of the minimum wage requires a comparison of employment outcomes between workers who are affected by a change in the minimum wage (treatment group) and workers who are not affected (control group); or alternatively, comparisons between groups of workers whose wages are changed by different amounts due to a change in the minimum wage. Hence, the starting point for empirical analysis on this topic is to describe how these groups of workers will be defined.

The first main contribution of this report is to describe the methods used in international research to identify workers who are and who are not affected by the minimum wage (or whose wages are affected by different amounts). This is intended to provide a basis for considering whether any of the approaches might be feasible in Australia.

For each method, I present an overview of: (i) the method by which the effect of the minimum wage on employment is identified; (ii) some key examples of studies that have used the method; (iii) what data are needed to apply the method; (iv) details of Australian studies that have used the method; and (v) the main limitations or issues currently being debated about the method.

The second main contribution of the report is to draw on the international literature to describe the main issues that need to be taken into account in doing empirical analysis of the employment effects of the minimum wage.

Section 2 of the report provides a brief overview of difficulties with doing research in Australia on the employment effects of the minimum wage. Section 3 describes the main methods used in international research to identify groups of workers who are and who are not affected by changes to a minimum wage. Other general issues regarding empirical analysis on the employment effects of the minimum wage are addressed in section 4. A summary of the implications from international research for future Australian research on the employment effects of the minimum wage is provided in section 5.

2 Why doing research on the employment effect of minimum wages in Australia is difficult

The main obstacle to research on the employment effects of the minimum wage in Australia has been the existence of a plethora of wage minima. Under the award system in Australia, rather than a single minimum wage, workers covered by different modern awards have different binding minimum wages. Individual awards specify a set of binding minimum wage rates that vary according to different criteria, such as a worker's skill level, industry, location and age. As an indication of the complexity of the system, in 1997 there were 1745 Federal and 656 State awards in just South Australia, Tasmania and Western Australia (Commonwealth Department of Workplace Relations and Small Business, 1998, pp. 14–19); and the award for TCF workers specified over 700 separate job classifications and the metal industry award had 348 categories of workers (Keating and Dixon, 1989, p. 28). Even with the shift to the modern award system in the 2000s, there remain 122 modern awards, generally with many different minimum wage rates specified in each award.

Therefore, in Australia, a comprehensive study of the employment effects of the full system of minimum wages would need to examine the impact of changes to the vast number of minimum wages that are specified in awards. To be able to do this analysis it is necessary to have data that: (a) links workers or jobs to the award by which they are covered; and (b) identifies whether the worker or job is being paid the award minimum wage rate or is being paid an over-award wage rate (since only in the former case can it be assumed that a change to the minimum wage rate will affect the wage paid). Until recently, there have not been data sets in Australia that have provided this information. (Appendix 1 provides an overview of available Australian data sources.) The task of doing empirical analysis has been further complicated by the likelihood that increases to the minimum wage will spill over from workers who are being paid the minimum wage rate to workers being paid above the minimum rate, therefore making it difficult to identify groups of workers who are and who are not affected by changes to the minimum wage. Identifying groups of workers who are and who are not affected by changes to the minimum wage is also made difficult during time periods where there has been a process of almost continuous adjustments to awards for different groups of workers.

Over time, the lowest award wage rate in (what is now) the *Manufacturing and Associated Industries and Occupations Award 2010*, category C14, has come to be referred to in Australia as the national minimum wage (NMW), and is the focus in the annual wage review undertaken by the Fair Work Commission. Having the minimum wage for one group of workers specified as the national minimum has not, however, created any extra leverage for empirical analysis of the employment effects of the minimum wage. This is because so few workers appear to have their wages directly determined by the NMW. A distinctive feature of the Australian wage distribution is the absence of a spike at the minimum wage level (Healy and Richardson, 2006, p. 8); and even approaches to calculating the proportion of workers to whom the NMW may apply, which measure the percentage of 'low pay' workers whose wage rate is within a specified range of the minimum rate, generally find that it is between 2 to 4 percent of workers (Yuen et al., 2018).

3 An overview of research methods used in international studies

3.1   Introduction

All empirical research on the employment effect of the minimum wage shares a common basis for identifying that effect. Employment outcomes for a treatment group of workers who are affected by a change to the minimum wage are compared with a control group of workers who are not affected by the change to the minimum wage; or alternatively, employment outcomes are compared between groups of workers whose wages are changed by different amounts due to a change in the minimum wage.

An example can illustrate why this approach is necessary. Suppose that the level of the minimum wage for a group of workers is increased, and that it is possible to observe the level of employment for those workers before and after the increase in the minimum wage. It might be thought that this information is sufficient to identify the effect of the minimum wage on employment. For example, by taking the ratio of the percentage change in employment and the percentage change in the minimum wage, an estimate of the elasticity of employment to the minimum wage can be derived. But there is a problem. Other factors are also likely to have affected the level of employment between the time prior to and after the minimum wage increase—such as macroeconomic conditions that affect labour demand. Therefore, to isolate the effect of the minimum wage on employment, it is necessary to know how employment for the group of workers would have changed if the minimum wage had not increased. Of course, it is not possible to know this information for workers who had their minimum wage increased. That is, we cannot observe what would have happened to employment without an increase in the minimum wage for the same group of workers for whom the minimum wage did actually increase. Hence, a control group is required, a group of workers who are thought similar enough to the group of workers whose minimum wage was increased, but who did not get an increase in their minimum wage. The experience of this control group can be regarded as showing what would have happened to employment for workers who received the increase in minimum wage, had they not received that increase.

Information on employment outcomes for workers who were and were not affected by the change to the minimum wage can then be combined to identify the effect of the minimum wage on employment. For example, suppose that employment of workers who are affected by an increase in the minimum wage falls by 3 per cent, and for a control group who did not get a minimum wage increase falls by 2 per cent. In this situation, it can be inferred that the effect of the increase in the minimum wage is to reduce employment by 1 per cent. Although employment of the group who get the minimum wage increase decreased by 3 per cent, we interpret that 2 per cent of this decline was due to other factors, since this was the experience of the control group who did not have an increase in their minimum wage.

The implication from this discussion is that in order to identify the effect of minimum wages on employment, it is necessary to be able to examine employment outcomes for similar groups of workers who have and have not experienced changes in the minimum wage (or employment outcomes for similar groups of workers who have experienced different changes to their wages due to a change in the minimum wage).

International studies of the employment effects of the minimum wage have applied a variety of methods to define similar groups of workers who have and have not experienced changes in the minimum wage. These methods are summarised in Table 1, together with some examples of international and Australian studies which have used each of the methods. In the rest of this section,

each of these methods for identifying the employment effect of the minimum wage will be described in more detail.

3.2 Time

Method of identification

This method can be applied where there are time intervals during which there is no change in the minimum wage, and other time intervals where there are increases (usually of varying magnitudes) in the minimum wage. Workers in time intervals where there is no change in the minimum wage can, for example, provide a control group for comparison against workers in time intervals where increases in the minimum wage do occur.

Examples

Most studies using this method apply time-series regression analysis to estimate the relation between the minimum wage and aggregate employment for a specific group of workers. The focus in these studies usually has been on workers who are most likely to be affected by the minimum wage—such as younger workers. The regression models include controls for explanatory factors that might be expected to affect employment; and this is especially important for factors likely to be correlated with changes to the minimum wage. This method has been used most extensively to study minimum wage impacts in the United States (US). A canonical example is the study by Brown et al. (1983). That study examines the relation between the employment/population rate for 16–19 year olds and the Kaitz index (a measure of the minimum wage expressed as a ratio of average hourly earnings adjusted for the proportion of workers covered by the minimum wage), also controlling for other factors such as the rate of unemployment and school enrolment rate. It uses a time-series model with quarterly data for 1954 to 1979. Wellington (1991) uses the same approach to estimate the impact of the minimum wage for the longer period from 1954 to 1986. (Detailed reviews of time-series studies of the employment effects of the minimum wage are in Brown et al., 1982; Brown, 1999; Card and Krueger, 1995; Neumark and Wascher, 2008).

Data needed

Time-series data on: (i) Employment outcome measure; (ii) Minimum wage and other wage information needed to construct the minimum wage variable to be used; (iii) Other determinants of employment that it is thought desirable to control for.

The data will be of greatest value where available for groups of workers whose wage rates are most likely to be affected by an increase in the minimum wage—such as young workers or workers in low wage sectors. It is also necessary to have data covering a sufficient length of time period, ideally with a substantial amount of variation in the minimum wage.

Australian perspective

The time-series method has been the most common approach used in Australian research on employment effects of the minimum wage, especially in the earliest phase of that research. The focus of this research has been on estimating the relation between the employment of youth and a measure of the youth minimum wage, covering the 1980s to 2000s, for individual states in Australia (Mangan and Johnston, 1999; Powell, 2007; Lee and Suardi, 2011). As well, Junankar et al. (2000) estimate a series of regression models for categories of employment disaggregated by age, gender and industry. These time-series studies have used ABS Labour Force Survey or Census data. The standard empirical approach has been to estimate the impact of the minimum wage on employment; with the

other approach being to test for structural change in the employment series at the time of increase in the minimum wage.

<u>Main limitations/current issues</u>

Research using a time-series method seems to have petered out as it was recognised that it had substantial limitations as an approach to identify minimum wage effects. The major problem is the difficulty of controlling for other determinants of employment apart from the minimum wage. Being able to control for those other determinants is critical since, as Kennan (1995, p. 1955) notes, predicted changes in youth employment due to changes in minimum wages are small relative to month-to-month changes in employment.

3.3   Geographic

<u>Method of identification</u>

This method uses differences between geographic regions in the timing and size of changes to the minimum wage to create groups of workers who are and who are not affected by increases in the minimum wage. For example, workers in a region which does not experience a minimum wage increase in a time interval could, if its labour market is sufficiently similar, be a control group for workers in another region which did have an increase in its minimum wage in the same time interval.

<u>Examples</u>

A large literature in the US has used state-level variation in the minimum wage (for example, between states where the federal minimum was binding and states where a higher state-level minimum was binding) to identify the effect of the minimum wage on employment. There have been two types of studies using state-level variation in research undertaken on the minimum wage and employment. A first group of studies has applied a panel model approach. These studies use panel regression models to estimate the effect of changes to state-level minimum wages on state-level employment. A second group of studies use a case study approach. These studies most often apply the quasi-experimental difference-in-difference method to employment data for detailed geographic regions. Changes in employment from before and after an increase in the minimum wage are compared between a treatment region where employers needed to increase some workers' wages to match an increase in the minimum wage and a control region (or set of regions) in the same state or a nearby state that did not need to increase their workers' wages. (See Appendix 2 for an overview of the difference-in-difference method; for more detail on that method and other quasi-experimental approaches, see Borland et al., 2005; Angrist and Pischke, 2014). Both the panel model and case study approaches have usually focused on low-wage workers most likely to be affected by changes to the minimum wage, such as teenagers or workers in the fast food sector.

The benchmark panel study of the effect of the minimum wage on state-level employment is by Neumark and Wascher (1992). They use a minimum wage variable in the spirit of the Kaitz index— that takes account of whether it is the state or federal minimum wage that is binding in each state. Later studies using the panel study approach include Card et al. (2004); Allegretto et al. (2011, 2013); and Neumark and Wascher (2014a, 2014b).

The case study that has attracted most attention was by Card and Krueger (1994). That study compared changes in employment in fast food restaurants in Pennsylvania and New Jersey before and after an increase in the New Jersey minimum wage. Other research has examined alternative case study comparisons (for example, Katz and Krueger, 1992; Sabia et al., 2012; Jardim et al., 2017; Reich et al., 2017; and for a large-scale study see Dube et al., 2010).

Several studies in the United Kingdom (UK) have also used a geographic method to identify employment effects of the minimum wage. In the UK, since 1999 there has been a NMW, but not region-specific wage minima. Geographic variation in the impact of the minimum wage is therefore identified by regional differences in the 'bite' of the NMW that arise from differences between regions in the distribution of wages. The bite of the minimum wage is a proxy for the proportion of low-paid workers in a region (see, for example, Stewart, 2002). These studies estimate panel models for employment outcomes across regions over time with the proportion of low wage workers and other controls for regional-level labour market conditions. Other studies using this method are Dolton et al. (2010, 2012, 2016).

Data needed

Time-series data disaggregated at a regional level: (i) Employment outcome measure; (ii) Minimum wage and other wage information needed to construct the chosen minimum wage variable to be used; (iii) Other determinants of employment that it is thought desirable to control for.

The data are most likely to be of value where available for groups of workers whose wage rates are most affected by an increase in the minimum wage—such as young workers and workers in low wage sectors. It is necessary to have a data series of sufficient length (for example, to be able to control appropriately for trends in employment prior to changes to the minimum wage).

Australian perspective

The main example of Australian research using a geographic basis for identification is Leigh (2003, 2004a, 2004b). That research used six changes in the Western Australian minimum wage between August 1994 and March 2001 that occurred out of step with changes to the Federal Minimum Wage and changes to Western Australian payroll tax rates. The study applied difference-in-difference analysis to compare changes in employment in Western Australia from three months prior to three months after an increase in the minimum wage, against changes in employment in the rest of Australia over the same time period. The measure of employment is the full-time equivalent employment to population ratio. Analysis was undertaken for persons, and also by gender and for younger age groups likely to have been most affected by increases in the minimum wage.

Main limitations/current issues

Major issues with the geographic method are the choice of control group and the appropriate way to control for differences in labour market conditions between the treatment region where an increase in the minimum wage occurs and the control region(s). Why these issues are important is summarised by Dube (2011): 'Variation over the past two decades in minimum wages has been highly selective spatially, and employment trends for low-wage workers vary substantially across states …'

The main question regarding the choice of control group is whether the control group should be restricted to regions that are contiguous to the treatment region or whether non-contiguous regions may be a better control. (This debate is mainly carried out in papers by Dube et al., 2010; Allegretto et al., 2011; Allegretto et al., 2013; Neumark and Wascher, 2014a; Neumark and Wascher, 2014b.) An alternative suggested approach is to construct a control group from states not experiencing an increase in the minimum wage using a synthetic cohort method (Sabia et al., 2016; Powell, 2017).

Where it is thought that differences exist in labour market conditions between treatment regions where the minimum wage increases and the control region(s), a common approach has been to seek to control for those differences by including region-specific time trends to capture those differences. One issue raised about this approach has been the appropriate functional form to allow adequate

flexibility in the time trend. A second issue relates to potential bias in the estimated effect of the minimum wage on employment. With a short time period before an increase in the minimum wage it can be difficult to separate the time trend in employment from the effect of the minimum wage. This problem is exacerbated where it is thought that the effect of an increase in minimum wages is on employment growth rather than causing a one-off change in employment (Meer and West, 2013; Lee and Solon, 2011). Solutions suggested are to extrapolate trends estimated from the period prior to the increase in minimum wage, or to estimate separate trends for the periods prior to and following the increase in the minimum wage (Monras, 2015). To implement these solutions requires a sufficiently long period of data prior to the increase in the minimum wage. Another suggestion is to control for state-level effects using data on minimum wages and employment at two geographic levels—for example, at the county by state level. Thomson (2009) examines the impact of the minimum wage on employment between high and low wage counties controlling for state effects.

An issue that is receiving increased attention with regard to the geographic method is endogeneity of the minimum wage; for example, whether state-level minimum wages might be set on the basis of local labour market conditions. Baskaya and Rubinstein (2012) demonstrate that the state-level effective minimum wage in the US is procyclical—but only for those states where the effective minimum wage is the state minimum rather than the federal minimum. To deal with this endogeneity of the minimum wage variable they propose using an instrumental variables (IV) approach.

Analysis of employment data aggregated to the state-level also requires consideration of the appropriate method to calculate standard errors. Bertrand et al. (2004) argued for clustering standard errors by state to overcome possible serial correlation in panel studies of the effect of minimum wages (see also, Neumark and Wascher, 2008, pp. 70–71; Brewer et al., 2015).

Most of these potential limitations of the geographic approach are raised by Watson (2004) in his critique of the study by Leigh (2003, 2004a) of Western Australian minimum wage increases. First, Watson (2004, p.168) questions whether trends in employment outcomes in the rest of Australia are sufficiently similar to Western Australia to be used as a control group. Watson does not provide any evidence to support this claim; nor, however, does Leigh's response (2004b, p.175) entirely address the issue. While Leigh demonstrates that his regression findings are robust to including time effects, what is required to properly investigate this issue is a detailed comparison of employment trends in Western Australia and the rest of Australia. Second, Watson (2004, p. 169) makes the point that annual changes to the minimum wage in Western Australia can make it difficult to identify time periods before and after an increase in the minimum wage. This becomes especially relevant where employers take more than a few months to adjust employment to changes in the minimum wage. Leigh (2004, pp. 175–76) finds a significant negative effect on employment for windows of one to three months around minimum wage increases. If employers complete their adjustment to increases in minimum wages within three months, then these are valid estimates of the aggregate effect of the minimum wage on employment. But where adjustment by employers takes sufficiently long that there is overlap in the periods around minimum wage increases examined by Leigh, it is not possible to interpret the estimates without knowing more details of the adjustment process. Third, Watson (2004, p. 169) argues that there are problems with inference in Leigh's study due to the small size of employment changes caused by the minimum wage relative to the changes in total employment for Western Australia. Leigh (2004, p. 177) provides a convincing rebuttal of this point. Overall, it needs to be said that, while there are limitations with Leigh's study, these were shared by international studies using the geographic method that were being done at the same time; and the shift to using a geographic method was a major advance for Australian research, providing as it did a potentially stronger basis than the time-series method for identifying groups of workers affected and not affected by changes to the minimum wage.

3.4   By position in the distribution of wages

<u>Method of identification</u>

This method uses the position of a worker in the wage distribution to identify groups of workers whose wages are and are not affected by an increase in the minimum wage. Where the initial wage rate paid to a worker is above the old minimum wage and below the new minimum wage, then the wage should be increased to the new minimum wage; whereas a worker with a wage rate above both the old and new minimum wage should not receive a wage increase that is directly related to the increase in the minimum wage. Hence, it is possible to use workers with a wage rate above the new minimum wage, with characteristics sufficiently close to those of workers who will experience a wage increase due to the higher minimum wage, as a control group; and workers who do experience wage increases as the treatment group.

<u>Examples</u>

Using this method, the employment effect of the minimum wage is estimated using a difference-in-difference approach. This estimated effect is equal to the difference between the change in employment outcome for workers where the wage increased due to a new minimum wage and the change in employment outcome for workers where the wage was not increased due to the new minimum wage.

Studies using this method for the US include the initial study by Linnemann (1982) and subsequent studies by Currie and Fallick (1996) and Neumark et al. (2004). For the UK, studies using this method have been undertaken by Stewart (2004); Stewart and Swaffield (2008); Dickens et al. (2012); Bryan et al. (2012).

<u>Data needs</u>

Longitudinal worker-level data on: (i) Employment outcome measure; (ii) Hourly wage; (iii) Other determinants of employment that it is thought desirable to control for.

<u>Australian perspective</u>

The Productivity Commission (2015b) has used this method to identify the impact of changes to the minimum wage on employment in Australia. That study uses data on hourly wages and employment outcomes for individual workers from the Research and Evaluation Database (RED), an administrative dataset which captures all Australian Commonwealth Income Support (IS) recipients on a fortnightly basis from July 1998 onwards. It examines the effect on transitions in employment (job loss, hours worked, and job entry) of the annual increases to the minimum wage from 2008 to 2013. A difference-in-difference approach is used where the treatment group for each increase in the minimum wage is workers earning between the old minimum wage and new minimum wage; and the control group is workers who earn wages above the new minimum wage. Allocation to the treatment and control groups is based on classification at the beginning of each sample period prior to the annual increase in the minimum wage. Alternative definitions of the control group, and alternative ranges of hourly wage rates in the treatment and control groups, are tested. The pre-treatment period is defined as six months prior to the annual minimum wage increase in June, and the post-treatment period as six months following the increase in the minimum wage. A range of controls such as for age, current duration on income support and whether speaks English are included. Estimation is undertaken for youths (21 to 25 years) and males and females (21 to 64 years).

The Productivity Commission study is an impressive attempt to implement this method of identification on Australian data. However, as the report acknowledges, there are some major problems. First, a

high degree of churning by workers between wage levels makes assignment of workers to treatment and control groups problematic. Second, a majority of low-wage workers likely to be affected by increases to the minimum wage are excluded from the study as they do not receive income support payments. Third, the focus on the minimum wage means that the employment impact of wage adjustment for workers being paid award wage rates above the minimum wage is not included in the analysis.

<u>Main limitations/current issues</u>

A critical issue in using workers' positions in the wage distribution to identify whether they are affected by a change to the minimum wage is the choice of control group of workers. It is important for the control group of workers to be as similar as possible in their characteristics and labour market environment to the treatment group of workers. This might suggest that the best control group is workers with wages just above the new minimum wage. But a problem is that there may be spill-over effects from the minimum wage increase to the wages of workers with wages just above the minimum wage which would attenuate the estimated effect of the minimum wage on employment. A related issue is how broad to make the coverage of the control group. Defining the control group to include workers with wages in a larger range will have the benefit of increasing the sample size, but at the cost of likely making the sample less representative compared to the workers who are affected by the minimum wage increase.

One response is to choose a control group of workers with hourly earnings some margin above the new minimum wage, at a level high enough that it is not believed that there would be spill-over effects on wages from the increase in the minimum wage. An alternative response is to use a difference-in-difference-in-difference approach, using quasi-treatment and control groups from higher in the wage distribution (Bryan et al., 2012). The rationale for this approach is that the difference in changes in employment outcomes between the quasi-treatment and control groups should not reflect spill-over effects due to the change in the minimum wage, but may capture differences due to effects such as differences in responses to business cycle conditions by skill level. A further possible approach, suggested by Ashenfelter and Card (1981) is to find workers earning between the old and new minimum wages, some of whom are directly affected by the increase in the minimum wage (covered) and others who are not directly affected (uncovered).

Another issue that has been considered in studies using worker-level data is how to define the group of workers affected by a minimum wage increase. The usual approach has been to include all workers who earn between the old minimum wage and new minimum wage prior to the increase. However, some research has focused on a narrower group of workers who are also observed to be earning at or above the new minimum wage once it has been introduced. A potential difficulty with using the latter approach is that measurement error in wages is also likely to cause some workers to be misclassified as being affected by an increase in the minimum wage.

A further limitation of this method is that it is difficult to measure the effect of the minimum wage on transitions from non-employment to employment—and hence the method may be missing some of the impact on employment. This point matters because of evidence from several countries that increases in the minimum wage may reduce flows out of and into employment—for example, Brochu and Green, 2013; Dickson and Papps, 2016; and Dube et al., 2016. One approach for incorporating this aspect into analysis of the employment effects of the minimum wage has been to examine transitions from unemployment to employment following an increase in the minimum wage, using predicted wages for persons who are out of employment (for example, Bryan et al., 2012). An alternative, but more limited, approach is used by Dickens et al. (2009), who examine how an increase in the minimum wage

affects the probability that an individual was employed prior to the increase in minimum wage conditional on being employed after the increase. This analysis estimates whether the increase in the minimum wage affects the proportion of new hires among workers paid at the minimum wage.

3.5 By geography and position in the distribution of wages

<u>Method of identification</u>

This method uses a combination of the methods that are based on differences in the impact of the minimum wage by geography and workers' positions in the wage distribution. It applies a difference-in-difference-in-difference approach which estimates the employment effect of the minimum wage as the difference in: (i) The difference in changes in employment outcomes between workers earning above and below the new minimum wage in a region where an increase in the minimum wage occurs; and (ii) The difference in changes in employment outcome between workers in the same earnings categories in a region where an increase in minimum wage does not occur.

This method has the potential to provide an extra degree of correction for differences between the characteristics and labour market conditions of the treatment and control groups. As an example, suppose there is a spill-over from a minimum wage increase to workers earning above the minimum wage in the region where an increase in the minimum wage occurs. Then the estimated employment effect of the minimum wage will be biased downwards in analysis that uses only data from the region where the minimum wage increase occurred. This can potentially be controlled for by also differencing by the same difference in changes in employment between quasi-treatment and quasi-control groups of workers (earning in the same ranges) in a region where an increase in the minimum wage does not occur. This will control for the impact of the spill-over effect from the increase in the minimum wage on the estimated effect on employment, provided that the difference in changes in employment outcomes between groups of workers earning above and below the new minimum wage would be the same in all regions in the absence of a change in the minimum wage. A similar argument can be made regarding the benefit of using multiple groups of workers from the same region to control for unobserved region-level impacts on employment that might otherwise bias the estimated effect of the minimum wage on employment.

<u>Examples of studies</u>

Clemens and Wither (2014) use data on employment outcomes for individual workers to examine the impact of the federal minimum wage increase in the US in mid-2009. The treatment group is workers in states in the US where the minimum wage increased in mid-2009 due to the increase in the federal minimum wage, and who prior to the increase were earning between the old state minimum wage and the new federal minimum wage. The control group is workers in the same state earning above the new minimum wage, and workers in states where the increase in the federal minimum wage did not affect the state-level minimum wage. A standard set of fixed effects and proxies for state-level macroeconomic conditions are also included as controls. Clemens and Strain (2017) use the same approach to examine the impact of increases in state-level minimum wages in the US enacted in the two years from January 2015.

A related approach is used by Shannon (2011) to examine the employment effects of removing minimum wage rates for 15–16 year olds in six Canadian provinces between 1986 and 1998. In this study, 15–16 year olds in provinces which removed the minimum wage regulation are the treatment group and 15–16 year olds in provinces which did not remove their minimum wage regulation, as well as young people aged above 16 years in all provinces, are used as the control group.

<u>Data needed</u>

Data requirements are the same as for the method using position in the wage distribution, supplemented by data on region of employment for individual workers.

<u>Main limitations</u>

A cautionary note on this method is provided by Yuen (2003). That study is based on province-level differences in the minimum wage in Canada. It compares employment outcomes for workers earning between the old and new minimum wages in a province where an increase in minimum wage occurs, against workers earning close to their provincial minimum wage level in provinces where an increase in the minimum wage does not occur. It is argued that this approach is superior to the approach of also including in the control group workers earning above the minimum wage in all provinces, as doing this can introduce bias to the estimated effect of the minimum wage on employment due to differences in labour market conditions for workers earning above and below the minimum wage.

3.6   Job/Occupation/Industry

<u>Method of identification</u>

This method uses differences in the timing and/or size of changes in the minimum wage by job, industry or occupation to create groups of workers who are and who are not affected by an increase in the minimum wage. For example, workers in an occupation which does not experience an increased minimum wage in a time interval could, if the labour market is sufficiently similar, be a control group for workers in another occupation which did have an increase in its minimum wage in the same time interval. Obviously, this method relies on a system of job, occupation or industry-specific wage minima.

<u>Examples</u>

The main international research that has used this method has examined the impact of UK Wage Councils which set pay for low-pay workers in industries such as retail trade, catering and hairdressing up until 1992 (Machin and Manning, 1994; Dickens et al., 1999). These studies used a panel regression model to examine the relation between industry-level employment and the 'toughness ratio' (equal the ratio of the industry-level minimum wage to the average wage in that industry), controlling for other influences on employment.

<u>Data needed</u>

Time-series data disaggregated by job/industry/occupation: (i) Employment outcome measure; (ii) Minimum wage and other wage information needed to construct the minimum wage variable to be used; (iii) Other determinants of employment that it is thought desirable to control for.

These data will be of greatest value, where available, for the group of workers who are being paid at the minimum wage rate; or for groups of workers whose wage rates are most likely to be affected by an increase in the minimum wage—such as young workers and workers in low wage sectors. It is also necessary to have a data series of sufficient length; for example, to be able to control appropriately for trends in employment prior to changes in the minimum wage.

Australian perspective

A study by Bishop (2017) uses this method with job-level data. The job-level data are from the approximately 3000 firms which respond to each ABS Wage Price Index (WPI) survey. From the WPI, it is possible to obtain quarterly longitudinal job-level data on wages, hours of work and whether a job continued to exist. The study examines the impact on employment of adjustments to the minimum wage from 1998 to 2008 for a sample of private sector jobs being filled by adults who are paid an award wage rate. During this period, adjustments to the minimum wage were flat dollar amounts, hence creating variation in the percentage increase in award wages across jobs depending on the initial wage rate. That variation in changes to the hourly wage rate between jobs is the way that the employment effect of increases in the minimum wage is identified. A range of robustness checks are also undertaken—including a difference-in-difference-in-difference approach using as an extra control the difference in the change in employment outcomes between low-wage and high-wage workers whose wage rates were set by Enterprise Bargaining Agreements.

This study is a major development of research on the employment effect of the minimum wage in Australia. First, the study examines the employment effects of changes to the entire set of award minimum wages in Australia. Second, with data from the WPI, it is possible to link jobs to awards, and data on wage rates is likely to be more accurate than from other sources. Third, data from the WPI allow analysis of the flow-on from minimum wage increases to wage rates paid by employers.

Other Australian research using industry/occupation as a basis for identification of the employment effect of the minimum wage is Seltzer and Borland (2017). That study examines the effect of the 1896 Victorian Factory and Shops Act, which established Wages Boards to set trade-level minimum wage rates. The period covered by the study is from 1896 to 1913, during which just over 120 Wage Boards were established. A panel regression model is estimated for the relation between annual changes in trade-level employment and the trade-level minimum wage. Other determinants of employment are controlled for using trade and year fixed effects. An IV version of the model is also estimated using the 1907 Harvester judgement as an exogenous source of increase in minimum wages set by the Wage Boards in Victoria. Other potential channels of adjustment to minimum wage increases, including hours of work and ratios of younger and older workers allowed, are investigated.

Main limitations/current issues

A limitation of this method is the practical difficulties of obtaining data on employment for the same job/industry/occupation categories for which minimum wages are set. Employment data are usually collected by a national statistical agency using the industry/occupation classification system that reflects the current labour market structure. By contrast, regulation of wage-setting often reflects relevant categories from many decades ago, and hence can be difficult to integrate with the employment data.

This limitation does not apply to the Bishop (2017) study, which is based on data on jobs and wages that are linked to modern award classifications. Some limitations of that study, however, are that it is not possible to identify effects of the minimum wage on job creation; and there is a relatively limited time period following the increase in the minimum wage for which employment effects can be studied (as well, there is the same question of identifying employment effects from data on annual minimum wage increases as was raised by Watson (2004) regarding the study by Leigh (2003, 2004a)).

A further criticism of studies using job/industry/occupation variation in minimum wages is their failure to control for the possibility that choices made by the wage-setting body (for example, Wage Councils)

about minimum wage levels would usually be expected to take into account economic conditions in the sectors they cover (Neumark and Wascher, 2008, p. 93).

3.7   Establishment

Method of identification

This method uses variation in the impact of an increase in the minimum wage on workers' wages between establishments that occurs where there are inter-establishment differences in the distribution of wages. For example, an establishment with a higher proportion of workers earning below a new minimum wage will need to make a bigger average upward adjustment in wages paid to its workforce. Therefore, an establishment where all workers earn above a new minimum wage could, if its workforce is sufficiently similar, be a control group for another establishment which did need to increase the wages of some of its workforce due to the new minimum wage.

Examples

One study which has used this method in the UK is Machin et al. (2003). It focuses on the residential care sector where an establishment is defined as a home. The study uses regression analysis to examine the relation between the change in home-level employment and a home-level measure of changes to wage costs following the introduction of the NMW. The measure used is alternatively the proportion of workers in a home earning below the new minimum wage prior to its increase, or the average increase in wages needed to bring all workers in a home to the new minimum wage. Other influences on employment are also controlled for. Machin and Wilson (2004) extend the analysis by focusing on a particular group of low-pay workers in the residential care sector, care assistants.

In the US, Giuliano (2013) has examined the impact of the 1996 US federal minimum wage increase on store-level employment for a large retail firm. This study uses a similar approach to the earlier UK studies, by undertaking graphical and regression analysis of the relation between changes to store-level employment and the average store-level increase in wages necessary to bring all workers to the new federal minimum wage level, including other controls for store-level characteristics such as age, distribution of employees and location.

Data needed

Time-series data disaggregated by establishment: (i) Employment outcome measure; (ii) Data on earnings of individual workers by establishment; (iii) Other determinants of employment that it is thought desirable to control for. These data are likely to be of most value where they are also available disaggregated for groups of workers whose wage rates are most likely to be affected by an increase in the minimum wage, such as low wage workers.

Australian perspective

Harding and Harding (2004) examine the impact of the 2003 National Safety Net Adjustment on employment in small and medium sized businesses. The study is based on employer responses to a survey undertaken as part of a monthly Yellow Pages survey of those businesses. While the research method in this study still relies on variation between establishments in the impact of increases to the minimum wage on wage costs, the nature of the survey data means that the specific details of the method are a little different to the international research. The survey responses allow businesses that had at least one worker who was on a minimum award wage rate to be identified. Responses by those businesses on the effect of the safety net adjustment on employment are used to estimate effect on total employment and wage elasticity of employment for alternative time horizons.

<u>Main limitations/current issues</u>

A major potential limitation of the international studies using this method is whether the results on the employment effect of the minimum wage can be regarded as representative beyond the particular type of sector examined. For example, can the results found by Machin et al. (2003) be extrapolated to other sectors apart from the residential home care sector?

The Harding and Harding (2004) study does not have this problem as it was based on a representative survey of Australian businesses. But one issue with the study is reliance on employment data from employer responses which may have been biased due to being questioned about the effect of the safety net wage adjustment on employment. Also, data are reported at the aggregate level rather than (for example) deriving an estimate of wage elasticity of employment from establishment-level analysis of the relation between the change to wage costs and change in employment.

3.8   Age

<u>Method of identification</u>

This method uses differences in the minimum wage, or in the timing and size of changes in the minimum wage, by age of worker. For example, an age group which does not experience a minimum wage increase in a time interval could, if workers in that group are sufficiently similar, be a control group for another age group which did have an increase in its minimum wage in the same time interval.

<u>Examples</u>

Research on the New Zealand labour market by Hyslop and Stillman (2007) examined the impact of lowering the age at which a worker was required to be paid the adult minimum wage and of a substantial increase in the minimum wage for youth workers in the early 2000s. The effect of these changes was estimated using difference-in-difference analysis of the change in employment for the age group affected by the policy change compared to the change in employment for the age group not affected.

An alternative approach is used in a study in the UK by Fidrmuc and Tena (2013). The study applies a regression discontinuity approach to estimate the effect on employment when a worker reaches an age at which they must be paid a higher minimum wage (specifically, turning 18 and 22 years).

<u>Data needed</u>

Time-series data disaggregated by age: (i) Employment outcome measure; (ii) Minimum wage and other wage information needed to construct the minimum wage variable to be used; (iii) Other determinants of employment that it is thought desirable to control for. The data will be most useful where it covers a sufficient length of time to be able to control appropriately for trends in employment for the different age groups of workers prior to changes in the minimum wage.

<u>Australian perspective</u>

Olssen (2011) examines the impact on hours of employment of the increase in the minimum wage rate that occurs for youth in Australia according to their age. At the time of the study, it was typical that the minimum wage for workers aged 16 years was discounted by 50 per cent relative to the adult rate, and then increased by 10 per cent at each birthday up to the age of 21 years. This study uses a regression discontinuity approach to estimate the employment effect of the age-related increases in

the minimum wage. The window for analysis is from six months younger to six months older than each age cut-off. Data from the HILDA Survey from 2001 to 2008 are used for this analysis.

Main limitations/current issues

One issue with the panel model application of this method is the appropriate choice of control group. There is a trade-off involved in this choice. In the interests of having a control group that is as similar as possible to workers in the age group who experience the increase in the minimum wage, it seems sensible to choose a group of workers as close as possible in their ages. However, the closer the control group workers are in their characteristics, the more likely it is that they could be substituted for the treatment group workers who have their minimum wage increased—hence biasing the estimated effect of the minimum wage on employment. Another related issue is what range of ages should be included in the control group relative to the group of workers whose minimum wage is increased. Including a broader range of ages will increase the sample size, but may mean that the control group is less similar to the treatment group.

To illustrate these problems, suppose that the objective of a study of employment effects of the minimum wage is to examine the effect of an increase in the minimum wage for youth workers aged 18 to 20 years. Choosing a control group of workers aged 21 to 23 years might bias the estimated employment effect in two ways: first, if the increase in the minimum wage causes some workers who (for example) are aged 21 years to be substituted for workers aged 20 years; and second, where (for example) employment outcomes for workers aged 23 years are affected differently by business cycle conditions than for workers aged 18 years.

Another issue with using the age-based method is external validity. This is the question of whether findings on the impact of the minimum wage for young workers are representative of the effects for other workers whose wages are affected by the minimum wage. Of course, one response to this point is that a large proportion of workers who receive the minimum wage are young workers.

3.9   General issues

The international literature on the employment effects of the minimum wage, as well as providing guidance on possible methods for identifying treatment and control groups of workers, also suggests a variety of more general issues that should be considered in doing research on this topic, whatever the method of analysis that is applied. This section provides an overview of these general issues.

How to interpret the estimated effect of the minimum wage on employment?

Studies of the employment effects of a minimum wage generally focus on estimating a parameter that is the elasticity of employment for a specified group of workers to a change in the minimum wage. The interpretation of this parameter will differ depending on the group of workers and on the wage adjustment required for workers earning less than the new minimum wage to become compliant.

Suppose we are studying the employment effect of an increase in the minimum wage for a group of workers all of whom initially had wages equal to the previous minimum wage. The estimated elasticity of employment to the change in the minimum wage is:

$$e_{direct} = \frac{\%\Delta EMP}{\%\Delta MINW}$$

This is referred to as the direct elasticity. It shows the proportionate effect on employment where all workers have their wage adjusted by the same amount up to the new minimum wage.

Thinking of all workers needing to have their wage adjusted upwards by the same amount is obviously a simplification. What is more likely is that there will be a distribution of wages below the new minimum so that workers would need to have their wages adjusted upwards by different amounts. Furthermore, some employers may not comply with the requirement to increase wages of workers who earn less than the minimum wage, or may implement offsets (such as unpaid work time) that reduce the effect of the higher minimum wage on the cost of hiring workers earning the minimum wage. Now, the estimated elasticity becomes:

$$e_1 = e_{direct} * (\frac{\%\Delta W_{direct}}{\%\Delta MINW})$$

where $\%\Delta W_{direct}$ is the average percentage increase in the wages (or wage costs) of workers who were earning below the new minimum that is needed to raise their wages to the new minimum level. Workers who earn less than the new minimum wage will have wages that vary from the old minimum to just below the new minimum. Hence $\%\Delta W_{direct}$ will be less than the percentage change in the minimum wage, $\%\Delta MINW$. It follows that an estimated elasticity derived from this group of workers, and assuming that all workers are affected by the full percentage change in the minimum wage, is less than the direct elasticity by a proportion that reflects the ratio of the change in the minimum wage to the actual average change in wages.

Studies of the employment effects of a minimum wage almost universally examine samples that include both workers who earn above and below the new minimum wage. Suppose that a study is examining a sample that included both types of workers, and it is known that the only effect of the change to the minimum wage is a direct effect on workers previously earning below the new minimum wage. The estimated elasticity of employment to the change in minimum wage then is:

$$e_2 = e_{direct} * p_{direct} * (\frac{\%\Delta W_{direct}}{\%\Delta MINW})$$

The estimated elasticity for the sample that includes both types of workers now also reflects that there is only a subset of workers, p_{direct}, who are affected by the change in the minimum wage.

Suppose we have undertaken a study where an elasticity of employment with respect to changes in the minimum wage, e_2, has been estimated that is equal to 0.1. Suppose also that $\%\Delta MINW$ is 5 per cent, $\%\Delta W_{direct}$ is 2.5 per cent, and p_{direct} is 0.5. Then the direct elasticity is 0.4.

This description of the estimated elasticity of employment to an increase in the minimum wage establishes that the estimate can only be interpreted properly by knowing the extent to which employers comply with an increase the minimum wage. For example, where some employers do not comply with an increase in the minimum wage, only partially comply, or do comply but seek to offset the effect on wage costs by having employees work longer hours, the increase in minimum wages will have a smaller effect on wage costs, and therefore the impact on employment will be correspondingly smaller. The general point is that the estimated elasticity of employment to an increase in the minimum wage will vary with the extent of compliance by employers. Knowing the extent of compliance with a minimum wage increase is therefore essential for interpreting the estimated elasticity.

What employment outcome measure to use?

Most studies have used the number of persons employed as the measure to study the employment effect of the minimum wage. It is possible, however, that this measure misses part (or perhaps a large part) of the effect of the minimum wage. For example, employers might adjust to a higher minimum wage by reducing workers' hours of work, rather than decreasing the number of persons employed. Some research (for example, in the UK by Dickens et al., 2012) does indicate that the estimated responsiveness of employment to increases in the minimum wage is larger for hours of work than persons employed.

In addition to altering their existing workforces, employers may also respond to a change in the minimum wage by changing their hiring (job creation). Several international studies have found that increases in the minimum wage do indeed reduce flows into employment—for example, Brochu and Green, 2013; Dickson and Papps, 2016; and Dube et al., 2016. This dimension of adjustment to employment, however, is missed in some types of studies of the effects of the minimum wage; for example, where analysis is restricted to how employment outcomes change for a group of workers who were employed prior to an increase in the minimum wage.

Over what time period should the effect of the minimum wage be studied?

Findings on the employment effects of the minimum wage can be influenced by the choices of the time periods prior to and after the implementation of an increase in the minimum wage that are examined.

Regarding the time period prior to the increase, it is important to consider the possibility of anticipation effects. An anticipation effect can occur where an increase in the minimum wage is announced some time before the increase is to be implemented. This introduces the possibility that employers might increase workers' wages to the new minimum level, and hence also adjust employment in response to the increase in the wage, before the official date at which the increase in the minimum wage was intended to be implemented. Where anticipation effects might occur, in order to precisely identify the time period over which the increase in the minimum wage could have affected employment, it is important to analyse whether there is evidence of minimum wage workers having their wages increased prior to the implementation date.

The length of period after the increase in the minimum wage that is examined is important where it is possible that the impact of that increase on employment takes place over an extended period—for example, where the minimum wage increase ultimately causes employers to substitute capital for labour. Early work on the short-run and long-run effects of the minimum wage was undertaken by Baker et al. (1999) using Canadian data. They estimate a positive effect of the minimum wage on employment of teenagers using one-year differences, but a negative effect with longer differences or when a lagged minimum wage variable is included. Recent research by Aaronson et al. (2013) for the restaurant sector in the US also supports the importance of a long-term perspective with the finding that employment adjustment occurs mainly through exit and entry of establishments. Sorkin (2015) provides a theoretical analysis that argues for a more nuanced approach to estimating long-run effects of increases in the minimum wage that takes into account how those increases are eroded over time due to inflation.

What are the implications of significance levels for estimates of the effect of the minimum wage on employment?

In interpreting estimates of the employment effects of the minimum wage, priority has been given to the question of whether it is possible to reject that the effect equals zero. A notable feature of

minimum wage studies, however, has been the wide confidence intervals around those estimated effects of minimum wages on employment. Hence, while it may not be possible to reject the hypothesis that the effect of minimum wage on employment is zero, equally it may not be possible to reject that it is some relatively large negative (or positive) value.

This issue is addressed in recent research by Brewer et al. (2015). They argue that (p. 2): '…an excessive focus on rejecting or failing to reject a null hypothesis can result in a very misleading interpretation of the statistical evidence. One common recommendation is that researchers present confidence intervals, as this summarises what values of the parameters of interest would be rejected (in a statistical sense) by the data.' Following on from this recommendation, they estimate confidence intervals for the employment effects of an increase in the minimum wage in the UK, applying the same regression model as in Bryan et al. (2012). The confidence intervals they estimate are wide, including large positive and negative values. For example, for one specification of their regression model they report 95 per cent confidence intervals on the effect of a one per cent increase in the minimum wage of between about –1.5 and +1.5 per cent for males, and –0.7 to +0.8 for females.

Heterogeneity in the employment effects of the minimum wage

The impact of the minimum wage on employment will be largest, other things equal, for those workers whose wages experience the largest rise when there is an increase in the minimum wage. That is why, for example, some US minimum wage research has focused on young workers or workers in low-wage sectors.

There are other potential dimensions of heterogeneity in the impact of the minimum wage that could also be considered. As one example, Yuen (2003) finds heterogeneity in the size of impact according to the degree of permanence of low earnings for individual workers. More recently, Strain and Brummond (2016) suggest that the impact may depend on the type of increase in the minimum wage —such as whether the increase is generated by a regular indexing of the minimum to inflation or is a one-time or multi-phase statutory increase.

4 Lessons for Australia

Analysis of international research on the employment effects of the minimum wage suggests a variety of potential methods that would be worthwhile to explore for application in Australia. These methods involve identifying groups of workers who are and are not affected by a change in the minimum wage on the basis of:

- geographic location;
- position in the distribution of wages;
- occupation/industry/establishment; and
- age.

Potential data sources with information on wages and employment outcomes for individual workers that could be investigated for undertaking this research include ABS data sources (such as the LFS, EEH and WPI); government administrative data; the HILDA Survey; and firm-level personnel records.

A check-list of issues to consider in planning research should include:

- For what group of workers should the analysis be undertaken?
- Can treatment and control groups be identified?
- What is the degree of compliance by employers with increases in the minimum wage?
- How should/can the employment outcome be represented?

    (i) What measure of employment—for example, persons employed or hours?

    (ii) Can the impact on hiring (job creation) be captured?

    (iii) How should the impact on employment be specified—for example, level or growth rate?

- How should differences in labour market conditions between the treatment and control groups be controlled for?
- What other explanatory variables for employment should be included?
- Are changes to the minimum wage exogenous to labour market conditions?
- What should be the time period for which the employment effect of a change in the minimum wage is examined?
- What method will be used to calculate standard errors?
- What approach will be taken to report the findings?
- How representative will the findings be?

Table 1: Methods of identifying the employment effect of the minimum wage

Method of identification	How impact of minimum wage on employment identified	International examples	Australian examples
Time	Variation over time in size of changes in minimum wage	United States – Brown et al. (1983); Wellington (1991); Card and Krueger (1995)	Mangan and Johnston (1999); Junankar et al. (2000); Wheatley (2009); Lee and Suardi (2011)
Geographic	Variation in timing and size of changes to minimum wage between geographic regions—e.g. between states	United States – Neumark and Wascher (1992); Card and Krueger (1994); Dube et al. (2010); Meer and West (2013); Canada – Baker et al. (1999); Campioletti et al. (2006); United Kingdom – Dolton et al. (2012)	Leigh (2003, 2004a, 2004b)
By position in the distribution of wages	Variation in impact of changes to minimum wages on wages paid to workers depending on their position in the distribution of wages	United States – Linneman (1982); Currie and Fallick (1996); Neumark et al. (2004); Canada – Yuen (2003); Campioletti et al. (2005); United Kingdom – Stewart (2004); Dickens et al. (2009, 2012)	Productivity Commission (2015b)
Combination of geography and position in distribution of wages	Variation in timing and size of changes to minimum wages by geographic region and workers' positions in the distribution of wages	United States – Clemens and Wither (2014); Clemens and Strain (2017); Canada – Yuen (2003)	

Job/Occupation/Industry	Variation in timing and size of changes to minimum wage between occupation and/or industry groups	United Kingdom – Machin and Manning (1994); Dickens et al. (1999)	Bishop (2017); Seltzer and Borland (2017)
Establishment	Variation in impact of changes to minimum wages on workers' wages between establishments	United States – Giuliano (2013); United Kingdom - Machin et al. (2003); Machin and Wilson (2004)	Harding and Harding (2004)
Age	Variation in timing and size of changes to minimum wage between workers by age	Canada – Shannon (2011); United Kingdom – Fidrmuc and Tena (2013); New Zealand – Hyslop and Stillman (2007)	Olssen (2011)

References

Aaronson, D., E. French and I. Sorkin (2015), 'Industry dynamics and the minimum wage: A putty-clay approach', mimeo.

Allegretto, S., A. Dube and M. Reich (2011), 'Do minimum wages really reduce teen employment? Accounting for heterogeneity and selectivity in panel data', Industrial Relations, 50, 205-40.

Allegretto, M., A. Dube, M. Reich and B. Zipper (2013), 'Credible research designs for minimum wage studies', IZA Discussion Paper no.7638.

Angrist, J. and J-S, Pischke (2014), Mastering Metrics: The Path from Cause to Effect (Princeton, NJ; Princeton University Press).

Ashenfelter, O. and D. Card (1981), 'Using longitudinal data to estimate the employment effects of the minimum wage', London School of Economics, Discussion paper no.98.

Baker, M., D. Benjamin and S. Stanger (1999), 'The highs and lows of the minimum wage: A time-series cross-section study of the Canadian law', Journal of Labor Economics, 17, 318-50.

Balaska, Y. and Y. Rubinstein (2012), 'Using federal minimum wages to identify the impact of minimum wages on employment and earnings across the US states', mimeo.

Belman, D. and P. Wolfson (2014), What Does the Minimum Wage Do? (WE Upjohn Institute for Employment Research).

Bishop, J. (2017), 'The effect of minimum wage increases on wages, hours worked and job loss', mimeo.

Borland, J., Y. Tseng and R. Wilkins (2005), 'Experimental and Quasi-Experimental Methods of Microeconomic Program and Policy Evaluation', pages 83-118 in Quantitative Tools for Microeconomic Policy Analysis (Canberra, Ausinfo).

Brochu, P. and D.A. Green (2013), 'The impact of minimum wages on labour market transitions', Economic Journal, 123, 1203-35.

Brown, C. (1999), 'Minimum wages, employment and the distribution of income', pages 2101-2162 in O. Ashenfelter and D. Card (eds.) Handbook of Labor Economics Volume 3 (Elsevier).

Brown, C., C. Gilroy and A. Kohen (1982), 'The effect of the minimum wage on employment and unemployment', Journal of Economic Literature, 20, 487-528.

Brown, C., C. Gilroy and A. Kohen (1983), 'Time-series evidence of the effect of the minimum wage on youth employment and unemployment', Journal of Human Resources, 18, 3-31.

Bryan, M., A. Salvatori and M. Taylor (2012), 'The impact of the National Minimum Wage on earnings, employment and hours through the recession', Report to the UK Low Pay Commission.

Burkhauser, R., K. Couch and D. Wittenburg (2000), 'A reassessment of the new economics of the minimum wage literature with monthly data from the Current Population Survey', Journal of Labor Economics, 18, 653-80.

Campioletti, M., T. Fang and M. Gunderson (2005), 'Minimum wage impacts on youth employment transitions, 1993-99', Canadian Journal of Economics, 38, 81-104.

Campioletti, M., M. Gunderson and C. Riddell (2006), 'Minimum wage impacts from a pre-specified research design: Canada 1981-1997', Industrial Relations, 45, 195-216.

Card, D., L. Katz and A. Krueger (2004), 'Comment on David Neumark and William Wascher, 'Employment effects of minimum and subminimum wages: Panel data on state minimum wage laws', Industrial and Labor Relations Review, 47, 487-96.

Card, D. and A. Krueger (1994), 'Minimum wages and employment: A case study of the New Jersey and Pennsylvania fast food industry', American Economic Review, 84, 772-93.

Card, D. and A. Krueger (1995), Myth and Measurement: The New Economics of the Minimum Wage (Princeton University Press).

Clemens, J. and M. Wither (2014), 'The minimum wage and the great recession: Evidence of effects on the employment and income trajectories of low-skilled workers', National Bureau of Economic Research Working Paper no.20724.

Clemens, J. and M. Strain (2017), 'Estimating the employment effects of recent minimum wage changes: Early evidence, an interpretative framework, and a pre-commitment to future analysis', National Bureau of Economic Research Working Paper no.23084.

Commonwealth Department of Workplace Relations and Small Business (1998), Safety Net Review – Wages, November 1997-March 1998 (Canberra).

Currie, J. and B. Fallick (1996), 'The minimum wage and the employment of youth: Evidence from the NLSY', Journal of Human Resources, 31(2), 404-28.

Dickens, R., S. Machin and A. Manning (1999), 'The effects of the minimum wage on employment: Theory and evidence', Journal of Labor Economics, 17, 1-22.

Dickens, R., R. Riley and D. Wilkinson (2009), 'The employment and hours of work effects of the changing National Minimum Wage', Report for the Low Pay Commission.

Dickens, R., R. Riley and D. Wilkinson (2012), 'A re-examination of the impact of the UK national minimum wage on employment', University of Sussex, Economics Department Working Paper no.46-2012.

Dickson, M. and K. Papps (2016), 'How the National Minimum Wage affects flows in and out of employment: An investigation using worker-level data', Report for the UK Low Pay Commission.

Dolton, P., C. Bondibene and J. Wadsworth (2010), 'The UK National Minimum Wage in retrospect', Fiscal Studies, 31(4), 509-34.

Dolton, P., C. Bondibene and J. Wadsworth (2012), 'Employment, inequality and the UK National Minimum Wage over the medium-term', Oxford Bulletin of Economics and Statistics, 74(1), 78-106.

Dolton, P., C. Bondibene and M. Stops (2015), 'Identifying the employment effect of invoking and changing the minimum wage: A spatial analysis of the UK', Labour Economics, 37, 54-76.

Dube, A., W. Lester and M. Reich (2010), 'Minimum wage effects across state borders: Estimates using contiguous counties', Review of Economics and Statistics, 92, 945-64.

Dube, A., M. Lester and M. Reich (2016), 'Minimum wage shocks, employment flows and labor market frictions', Journal of Labor Economics, 34(3), 663-704.

Fidrmuc, J. and J. Tena (2013), 'National Minimum Wage and employment of young workers in the UK', CESIFO Working Paper 4286.

Giuliano, L. (2013), 'Minimum wage effects on employment, substitution, and the teenage labor supply: Evidence from personnel data', Journal of Labor Economics, 31, 155-94.

Hafner, M., J. Taylor, P. Pankowska, M. Stepanek, S. Nataraj and C. van Stolk (2016), 'The impact of the National Minimum Wage on employment: A meta-analysis', Report for the UK Low Pay Commission.

Harding, D. and G. Harding (2004), 'Minimum wages in Australia: An analysis of the impact on small and medium sized businesses', Report to the Commonwealth Department of Employment and Workplace Relations.

Healy, J. and S. Richardson (2006), 'An updated profile of the minimum wage workforce in Australia', Australian Fair Pay Commisssion, Research report no.4/06.

Hirsch, B., B. Kaufman and T. Zelenska (2011), 'Minimum wage channels of adjustment', IZA Discussion paper no.6132.

Hoffman, S.D. (2016), 'Are the effects of minimum wage increases always small? A reanalysis of Sabia, Burkhauser and Hansen', Industrial and Labor Relations Review, 69(2), 295-311.

Hyslop, D. and S. Stillman (2007), 'Youth minimum wage reform and the labour market in New Zealand', Labour Economics, 14, 201-30.

Jardim, E., M. Long, R. Plotnick, E. van Inwegen, J. Vigdor and H. Wething (2017), 'Minimum wage increases, wages and low-wage employment: Evidence from Seattle', National Bureau of Economic Research Working Paper no.23532.

Junankar, R., G. Belchamber and M. Waite (2000), 'The youth labour market: Anecdotes, fables and evidence', Economic and Labour Relations Review, 11, 159-86.

Katz, L. and A. Krueger (1992), 'The effect of the minimum wage on the fast food industry', Industrial and Labor Relations Review, 46, 6-21.

Keating, M. and G. Dixon (1989), Making Economic Policy in Australia 1983-1988 (Melbourne, Longman Cheshire).

Kennan, J. (1995), 'The elusive effects of minimum wages', Journal of Economic Literature, 33, 1950-65.

Lee, J.Y. and G. Solon (2011), 'The fragility of estimated effects of unilateral divorce laws on divorce rates', National Bureau of Economic Research Working Paper no.16773.

Lee, W.S. and S. Suardi (2011), 'Minimum wages and employment: Reconsidering the use of a time series approach as an evaluation tool', British Journal of Industrial Relations, 49, s376-s401.

Leigh, A. (2003), 'Employment effects of minimum wages: Evidence from a quasi-experiment', Australian Economic Review, 36(4), 361-73.

Leigh, A. (2004a), 'Employment effects of minimum wages: Evidence from a quasi-experiment - Erratum', Australian Economic Review, 37(1), 102-05.

Leigh, A. (2004b), 'Minimum wages and employment - Reply, Australian Economic Review, 37(2), 173-79.

Linneman, P. (1982), 'The economic impacts of minimum wage laws: A new look at an old question', Journal of Political Economy, 90(3), 443-69.

Machin, S. and A. Manning (1994), 'Minimum wages, wage dispersion and employment: Evidence from the UK Wages Councils', Industrial and Labor Relations Review, 47, 319-29.

Machin, S., A. Manning and L. Rahman (2003), 'Where the minimum wage bites hard: Introduction of minimum wages to a low wage sector', Journal of the European Economic Association, 1(1), 154-80.

Machin, S. and J. Wilson (2004), 'Minimum wages in a low-wage labour market: Care homes in the UK', Economic Journal, 114, C102-C109.

Mangan, J. and J. Johnston (1999), 'Minimum wages, training wages and youth employment', International Journal of Social Economics, 26, 415-29.

Manning, A. (2013), 'Minimum wages: A view from the UK', Perspektiven der Wirtschaftspolitik, 14, 57-76.

Manning, A. (2016), 'The elusive employment effect of the minimum wage', Centre for Economic Performance, Discussion Paper no.1428.

Meer, J. and J. West (2013), 'Effects of the minimum wage on employment dynamics', National Bureau of Economic Research Working Paper no.19262.

Monras, J. (2015), 'Minimum wages and spatial equilibrium: Theory and evidence', IZA Discussion Paper 9460.

Neumark, D. (2017), 'The employment effects of minimum wages: Some questions we need to answer', National Bureau of Economic Research Working Paper no.23584.

Neumark, D. and W. Wascher (1992), 'Employment effects of minimum and sub-minimum wages: Panel data on state minimum wage laws', Industrial and Labor Relations Review, 46, 55-81.

Neumark, D. and W. Wascher (2008), Minimum Wages (MIT Press).

Neumark, D., J. Salas and W. Wascher (2014a), 'Revisiting the minimum wage-employment debate: Throwing out the baby with the bathwater?', Industrial and Labor Relations Review, 67, 608-48.

Neumark, D., J. Salas and W. Wascher (2014b), 'More on recent evidence on the effects of minimum wages in the United States', National Bureau of Economic Research, Working Paper no.20619.

Neumark, D., M. Schweitzer and W. Wascher (2004), 'Minimum wage effects throughout the wage distribution', Journal of Human Resources, 39(2), 425-50.

Olssen, A. (2011), 'The short run effects of age based youth minimum wages in Australia: A regression discontinuity approach', Paper presented at New Zealand Association of Economists Annual Conference.

Plowman, D. (2000), 'The minimum wage and unemployment', mimeo, Curtin University Graduate School of Business.

Powell, D. (2016), 'Synthetic control estimation beyond case studies: Does the minimum wage reduce employment?', RAND Labor and Population Working Paper WR-1142.

Productivity Commission (2015a), 'Australian empirical studies of wage employment effects', Appendix C in Workplace Relations Framework (Canberra).

Productivity Commission (2015b), 'Exploring the effects of minimum wage increases on employment using a large administrative dataset', Technical Supplement, <u>Workplace Relations Framework</u> (Canberra).

Reich, M., S. Allegretto and A. Godney (2017), 'Seattle's minimum wage experience 2015-16', Center on Wage and Employment Dynamics, Policy Brief.

Sabia, J., R. Burkhauser and B. Hansen (2012), 'Are the effects of minimum wages always small? New evidence from a case study of New York State', <u>Industrial and Labor Relations Review</u>, 65, 350-76.

Sabia, J., R. Burkhauser and B. Hansen (2016), 'When good measurement goes wrong: New evidence that New York State's minimum wage reduced employment', <u>Industrial and Labor Relations Review</u>, 69(2): 312-19.

Seltzer, A. and J. Borland (2017), 'The impact of the 1896 Factory and Shops Act on Victorian labour markets', <u>Journal of Economic History</u>, forthcoming.

Shannon, M. (2011), 'The employment effects of lower minimum wage rates for young workers: Canadian evidence', <u>Industrial Relations</u>, 50, 629-55.

Sorkin, I. (2015), 'Are there long-run effects of the minimum wage?', <u>Review of Economic Dynamics</u>, 18(2), 306-33.

Stewart, M. (2002), 'Estimating the impact of the minimum wage using geographical wage variation', <u>Oxford Bulletin of Economics and Statistics</u>, 64, 583-605.

Stewart, M. (2004), 'The impact of the introduction of the UK minimum wage on the employment probabilities of low wage workers', <u>Journal of the European Economic Association</u>, 2, 67-97.

Stewart, M. and J. Swaffield (2008), 'The other margin: Do minimum wages cause working hours adjustments for low-wage workers?', <u>Economica</u>, 75, 148-67.

Strain, M.R. and P. Brummond (2016), 'Real and permanent minimum wages', AEI Working Papers no.875967.

Thompson, J.P. (2009), 'Using local labor market data to re-examine the employment effect of the minimum wage', <u>Industrial and Labor Relations Review</u>, 62(3), 343-66.

Watson, I. (2004), 'Minimum wages and employment: Comment', <u>Australian Economic Review</u>, 37(2), 166-72.

Wellington, A. (1991), 'Effects of the minimum wage on the employment status of youths', <u>Journal of Human Resources</u>, 26, 27-46.

Yuen, A. (2003), 'The effect of minimum wages on youth employment in Canada: A panel study', <u>Journal of Human Resources</u>, 38(3), 647-72.

Yuen, K., G. Ellis and L. Nelms (2018), 'Characteristics of workers earning the national minimum wage rate and of the low paid', Fair Work Commission, mimeo.

Appendix 1: Australian data sources

Established Australian labour market data sources that can provide some analysis of employment are primarily obtained from the ABS. In addition, the HILDA Survey, and the RED, which is administered by the Department of Jobs and Small Business, can also provide information on the labour market. Table 1 summarises these data sources.

The key variables to undertaking the analysis of employment effects of minimum wages are labour force status, hours worked, hourly earnings and method of setting pay. These variables must be captured in a way that enables changes in employment to be tracked over time. Data on employment arrangements is generally regarded as being more reliable when obtained from employers who have access to payroll data.

Table 2: Australian data sources

Source	Respondent	Frequency	Type	Key variables	Other variables	Comments/Limitations
				ABS sources		
Survey of Employee Earnings and Hours (EEH)	Employers	Biennial (1996–2016)	Cross-section	Employment Method of setting pay Jurisdiction Earnings Hours paid for	Sex Managerial status Industry Occupation Business size Age Employment type Sector Status in employment	• Data are annual • Hours paid for does not capture all hours worked • Survey is not longitudinal
Labour Force Survey (LFS)	Households	Monthly/Quarterly	Time series	Labour force status Hours worked	Sex Age Industry (quarterly) Occupation (quarterly)	• Does not capture data on earnings • Survey respondents are only included for 8 consecutive months • Data are on aggregate outcomes • Does not capture method of setting pay
Longitudinal Labour Force Survey confidentialised unit record file	Households	Monthly (one release: January 2008 to December 2010)	Time series	Labour force status Hours worked Weekly gross income from all sources (in $100 ranges)	Sex Industry Occupation Age Employment type Sector	• Hourly earnings cannot be derived • Does not capture overtime hours or earnings • Does not capture method of setting pay • Survey respondents are only included for 8 consecutive months

Source	Respondent	Frequency	Type	Key variables	Other variables	Comments/Limitations
Labour Force Survey and Labour Mobility confidentialised unit record file	Households	Annual (February 2012 latest)	Cross-section	Labour force status Hours worked Whether changed employer in last 12 months	Sex Age Employment type Business size Status in employment	• Infrequent data • Does not capture data on earnings • Does not capture method of setting pay
Participation, Job Search and Mobility (PJSM) confidentialised unit record file	Households	Annual (first release: February 2016)	Cross-section	Labour force status Hours worked Whether changed employer in last 12 months	Sex Age Sector Status of employment Occupation Industry Employment type Business size	• Annual data • Does not capture data on earnings • Does not capture method of setting pay •
Labour Accounts	Australian-resident businesses and households	Annual (first release: 2010–11 to 2015–16)	Cross-section	Labour force status Wages and salaries Hours worked Hours paid for Total number of jobs	Industry Vacancies	• Data linked from various surveys, such as Labour Force, Job Vacancy, EEH and National Accounts • Annual data • Does not capture method of setting pay
Business Longitudinal Database (BLD)	Administrative records	Annual (ceased)	Longitudinal (5-year panel)	Employment	Industry Sector Years of operation Changes to income/ profitability/productivity	• Excludes some industries • Does not capture earnings • Does not capture method of setting pay • Only contains small and medium-sized businesses

Source	Respondent	Frequency	Type	Key variables	Other variables	Comments/Limitations
Business Longitudinal Analysis Data Environment (BLADE) Undertaken in partnership with the Department of Industry, Innovation and Science.		Annual (only information paper released)	Longitudinal (2001–02 to 2012–13)	Total salary (wages and other payments) Employment (incl. full-time/part-time/casual)	Industry Age of business Profit/loss Income/expenses Labour costs	• Does not capture method of setting pay • Excludes some industries
Employee Earnings and Jobs – microdata	Administrative data with survey data collected from ABS	First release: Jan 2016 (for 2011–12)	Cross-section	Gross payment Duration of job (in weeks)	Industry Employment size Annual business turnover Other jobs	• Integrated dataset – linking extract of EABLD 2011–12 with Personal Income Tax data compiled by ATO • Does not capture method of setting pay • Does not capture hours worked – hourly earnings cannot be derived
Other sources						
Household, Income and Labour Dynamics in Australia (HILDA) survey	Households	Annual (2001–2015)	Longitudinal	Labour force status Earnings Hours worked Method of setting pay	Sex Industry Occupation Business size Age Employment type Sector Status in employment	• Annual data • Earnings data and method of setting pay may be less reliable than data obtained from businesses • Cannot identify overtime hours or earnings • Survey undertaken from late July to early February

Source	Respondent	Frequency	Type	Key variables	Other variables	Comments/Limitations
Longitudinal Surveys of Australian Youth (LSAY)	Young people	Annual	Longitudinal	Employment Hours worked Earnings	Sex Age Occupation Employment type	• Annual data • Does not capture method of setting pay • Only captures youth • Attrition: 61.5% of 2009 cohort remained in 2010 and 28.5% in 2016
Research and Evaluation Database (RED)	Administrative records and business survey	Fortnightly (July 1998–present)	Longitudinal	Earnings Hours worked	Sex Age Other personal characteristics	• Only contains households that receive income support payments • Does not capture method of setting pay

Appendix 2: Difference-in-difference method

Difference-in-difference is an empirical method to estimate the impact of an intervention (for example, government policy or regulation) on a population who receive or are affected by the intervention. In this report, the intervention is the imposition of a minimum wage.

The difference-in-difference method estimates the impact of an intervention by taking the difference between: (i) the change in an outcome from before to after an intervention for a treatment group who are affected by the intervention; and (ii) the change in outcome over the same time interval for a control group who are not affected by the intervention.

An example can illustrate how this difference-in-difference estimate is derived. Suppose the intervention is an increase in the minimum wage for a group of workers and we are interested in studying the effect of the increase on employment. Assume that it is possible to identify the group of workers who are affected by the increase in the minimum wage, and it is also possible to identify a group of workers who are not affected. Define time 1 as a point in time prior to the increase in the minimum wage and time 2 as a point in time after the increase in the minimum wage. A difference-in-difference estimate of the impact of the increase in the minimum wage can then be calculated in three steps:

- Step 1] Calculate the change in employment from time 1 to time 2 for the group of workers who are affected by the increase in the minimum wage;

- Step 2] Calculate the change in employment from time 1 to time 2 for the group of workers who are not affected by the increase in minimum wage; and

- Step 3] Subtract the change in employment for the group not affected by the minimum wage increase (step 2) from the change in employment for the group affected by the minimum wage increase (step 1). This is the difference-in-difference estimate of the employment effect of the minimum wage.

For example, suppose that the change in employment from time 1 to time 2 for the group of workers affected by the minimum wage increase is –3 per cent; and that for the group of workers not affected by the minimum wage increase is –2 per cent. Then the difference-in-difference estimate is that the increase in the minimum wage caused a reduction in employment of 1 per cent.

An alternative to using the difference-in-difference method would simply be to use the change in employment for the group affected by the minimum wage as the estimated impact of the increase in the minimum wage. The problem with using this approach, often referred to as a 'before/after' approach, is that other influences on employment (such as macroeconomic conditions) may also have affected employment between the times prior to and after the increase in the minimum wage. The rationale of the difference-in-difference method is that those other influences on employment will be captured by the change in employment for the group not affected by the minimum wage increase, and can therefore be netted out by subtracting the change in employment for the group who are not affected by the increase in the minimum wage from the change in employment for the group who are affected.

In this way, the numerical example above can be given the following interpretation. The group who are not affected by the minimum wage increase experience a 2 per cent decrease in employment. Hence, we conclude that, even without the increase in the minimum wage, other factors would have caused employment to decrease by 2 per cent for the group who do have an increase in the

minimum wage. Therefore, of the overall 3 per cent decrease in employment for the group of workers who are affected by the minimum wage increase, it is inferred that 2 per cent was due to other factors, and 1 per cent to the increase in the minimum wage.

For this interpretation to be valid, a key assumption must be satisfied—it must be the case that the change in employment for the control group of workers who are not affected by the minimum wage increase must be the same as what would have happened for the treatment group of workers who are affected by the minimum wage increase, had they not received the minimum wage increase. Hence, a major aspect of empirical analysis applying to the difference-in-difference method is to be able to justify the choice of control group; and specifically, that the trend in outcomes for the control group is the same as would have been experienced by the treatment group, had they not experienced the intervention being analysed.

Most commonly, a difference-in-difference estimate of the impact of an intervention such as an increase in the minimum wage is derived from a regression model such as:

$$EMP_{it} = \alpha + \beta I + \gamma T + \delta I \cdot T + \theta X_{it} + \varepsilon_{it}$$

Where: EMP_{it} is employment status (or hours of work) of the ith individual in time period t; I is an indicator equal to one where an individual is in the group of workers affected by the minimum wage increase; T is an indicator equal to one for the time period following the increase in the minimum wage (assuming there are just two time periods, t=1 prior to the minimum wage increase, and t=2 after the increase has occurred); and X_{it} are other variables that might affect employment outcomes. In this regression model, the coefficient δ is the difference-in-difference estimate of the impact of the increase in the minimum wage. It represents the effect of the increase in the minimum wage on employment outcomes, controlling for any fixed difference in employment outcomes between the treatment and control groups, and for any difference in employment outcomes between the times prior to and after the minimum wage increase that affect both groups of workers equally.