The Redistributive Effects of a Minimum Wage Increase in New Zealand: A Microsimulation Analysis*

Nazila Alinaghi, John Creedy and Norman Gemmell†

Abstract

This paper examines the potential effects on inequality and poverty of a minimum wage increase, based on a microsimulation model which allows for labour supply responses. It then compares these outcomes with an alternative, commonly used policy of raising government welfare benefits, similarly aimed at poverty or inequality reduction. Results suggested that, due to the composition of household incomes, a policy of increasing the minimum wage appears to have a relatively small effect on the inequality of income per adult equivalent person, using several inequality indices. The minimum wage policy is not particularly well targeted at its objective, largely due to many low-wage earners being ssecondary earners in higher-income households, while many low-income households have no wage earners at all. However, an 'equivalent' policy of raising welfare benefits does not clearly demonstrate 'target superiority'. Results suggest that while raising benefits has a greater ability to reduce most poverty measures examined, substantially smaller inequality reductions are found to be associated with benefit increases compared to a minimum wage increase. Thus benefit increases represent a relatively effective strategy for poverty reduction, mainly by targeting sole parents, but (like minimum wages) are also relatively ineffective if inequality reduction is the objective.

JEL Classification: D63; H23; H31; I30

Keywords: Microsimulation, income inequality, poverty, minimum wage

*This paper is part of a larger project on 'Improving New Zealand's Tax Policy via International Tax Transfer Model Benchmarking', funded by an Endeavour Research Grant from the Ministry of Business, Innovation and Employment (MBIE) and awarded to the Chair in Public Finance. Access to the data used in this paper was provided by Statistics New Zealand in accordance with security and confidentiality provisions of the Statistics Act 1975. The results presented in this study are the work of the authors, not Statistics New Zealand. We have benefited from discussion with Christopher Ball, Nicolas Hérault and Guyonne Kalb.

†Victoria University of Wellington.

1 Introduction

The aim of this paper is to assess the potential distributional effects of an increase in the legal minimum wage in New Zealand. A distinctive feature of the analysis is that results are obtained using a behavioural tax microsimulation model, which allows for the *ceteris paribus* labour supply effects of minimum wage reforms to be examined.

Setting a legal minimum wage is a policy tool, commonly used across OECD countries, that is explicitly aimed at redistributing earnings towards low-paid workers or motivated as assisting workers with low bargaining power to receive a 'fair' wage (Gosling, 1996). While it may be tempting to assume that an increase in the minimum wage must be inequality-reducing, many low-wage individuals are in households that may have relatively high total incomes. Hence, if concern is with the distribution of income per adult equivalent person, it is not clear that a minimum wage policy is the most effective. Indeed, many low-income households consist of people who are not in the labour market and who therefore cannot benefit from a minimum wage increase; an aspect stressed in the US context by Burkhauser and Finegan (1989), and Burkhauser and Sabia (2007).[1]

In the present paper, interest focuses on the extent to which a minimum wage increase could reduce measures of inequality and poverty, while allowing for endogenous labour supply responses. It then considers how such effects compare with those generated by an 'equivalent' reform (to be defined below) to the tax-transfer system.

An important aspect of the behavioural microsimulation modelling here is that, in common with other tax microsimulation models, it abstracts from possible demand-side effects, to allow the *ceteris paribus* effects of labour supply responses to minimum wage reforms to be examined, in terms of hours worked. Demand-side effects of minimum wage policies have, of course, been extensively examined, often focusing on impacts further up the wage distribution, effects on unemployment and employment composition, or pass-through effects to consumer prices. One conclusion from the literature, reviewed briefly below, is that it has proved surprisingly difficult to identify consistent and substantive demand-side responses to minimum wage legislation. Regardless, given the possibility of various labour supply responses to legislated minimum wages, it is interesting to consider how large these are empirically and their ability to affect policy objectives of reduced inequality or poverty. The present paper addresses these questions using a behavioural tax-transfer microsimulation model applied to household data for New Zealand.

The modelling approach also enables the so-called 'impact effect' of the reform to be

[1] Creedy *et al.* (2010) demonstrate the importance of the heterogeneity of low-income households in New Zealand for the design of fiscal policies aimed at redistribution.

compared with the effects obtained after allowing for reform-induced behavioural responses. Furthermore, the explicit modelling of the choice between net income (income after direct taxes and transfers) and hours worked makes it possible to examine welfare metrics other than net income, and thus to allow for the welfare changes arising from changes in the consumption of leisure time. The paper therefore contributes to the small number of distributional studies which use a microsimulation model of this kind to examine minimum wage effects.

Section 2 briefly reviews evidence from previous studies with a focus on minimum wages. Section 3 describes minimum wage settings in New Zealand, and Section 4 briefly describes the simulation model approach used. The policy examined is described in Section 5. Simulation results for the distributional and social welfare outcomes of the policy change are reported in Section 6. To compare those results with an alternative policy reform, Section 7 defines an 'equivalent' social benefit reform to the simulated minimum wage increase, and compares inequality and poverty outcomes for the two cases. To explore the empirical impact here of the hypothesis that minimum wage increases may spill over to wages rates further up the wage distribution, Section 8 investigates comparable simulations which allow for substantial wage spillovers. Brief conclusions are drawn in Section 9.

2 Previous Literature

Previous literature on the economic impact of a legislated minimum wage has typically focused on demand-side effects on, for example, the wage distribution or employment, while a number of more recent studies have begun to use microsimulation approaches to examine the distributional effects of minimum wages with, or without, an allowance for supply-side responses.

Work in this tradition for New Zealand includes, for example, Maloney (1995), Chapple (1997), Pacheco and Maloney (1999), Hyslop and Stillman (2007); see Pacheco and Cruickshank (2007) for a review. In theory, a minimum wage could increase or decrease the demand for labour, depending on the nature of the labour market. For example, minimum wages could increase employment in a labour market characterized by monopsony (Manning, 2003).

The empirical literature is far from unanimous in its findings but has generally found small (positive or negative), if any, effects. It has also been suggested that many workers affected by minimum wage legislation are working in the non-traded sector, which necessarily does not face international competition and hence has less downward pressure on wages. In a recent overall evaluation of the empirical literature, Autor *et al.* (2016, p.61) conclude 'the employment impact of the minimum wage remains a contentious issue ... most estimates are very small. For example, the recent Congressional Budget Office (2014) report on the likely consequences of a 25 percent rise in the federal minimum wage ... concluded job losses would represent less than 0.1 percent of employment'.

Using a tax and transfer microsimulation model in which hours worked are held constant, Müller and Steiner (2009) analysed the effects on household incomes in Germany of introducing a mandated wage floor. They concluded that a national minimum wage would be ineffective in reducing poverty. Müller and Steiner (2013) extended their analysis in several ways, including adding behavioural adjustments induced by the minimum wage. They considered the distributional outcomes of a federal minimum wage allowing for labour supply, labour demand and consumption effects, and concluded that the German federal minimum wage slightly affects inequality among households with at least one minimum wage worker.

In a recent study for the UK, Atkinson *et al.* (2017) assessed the immediate impact on inequality and poverty of raising the national minimum wage (NMW), using a non-behavioural microsimulation approach.[2] They compared the distributional consequences of increasing the NMW with alternative tax and transfer reforms, finding that the 'first-round' effects of their proposed reforms would substantially reduce income inequality and relative poverty. However, they found the impact of further increases in the NMW to be modest. The general message from these and other studies is one of limited impacts on income inequality and poverty from introducing or increasing the minimum wage. This largely reflects the observation, mentioned above, that low-wage workers are often not concentrated at the bottom of household income distribution.

Another possible response to a legislated minimum wage concerns 'spillover' or 'ripple' effects which, if widespread, would substantially reduce the ability of an increase in the minimum wage to reduce inequality.[3] Spillovers may arise for two main reasons. Firstly, increases in the relative price of low-skilled workers, may induce employers to substitute from low-skilled to higher-skilled workers. The resulting increases in the demand for skilled workers pushes up their wages. Alternatively, where relativities among groups are considered important, the relative price of low-skilled workers may remain constant with increases in

[2] Atkinson *et al.* (2017, p. 319) suggested that, 'The impact described here, across the various reforms, are static, first-round effects and an overall assessment would need to incorporate judgements about the extent and nature of behavioural responses'. Brewer and De Agostini (2015) also used a non-behavoural model (the UK module of EUROMOD) to examine the interaction of a minimum wage with the tax-benefit system.

[3] It is, of course, possible that spillovers to wages just above the statutory minimum could nevertheless be inequality-reducing.

the minimum wage leading directly to wage increases for higher-skill workers further up the distribution (Neumark and Wascher, 2008).

Previous studies of such spillover effects have come to divergent conclusions: see, Autor *et al.* (2016), Stewart (2012) and Dickens and Mannings (2004). For example, some evidence for the US suggests some spillovers across the wage distribution, while the UK literature generally finds at most limited evidence of spillovers (Stewart, 2012). For the US, despite finding some support for spillovers, Autor *et al.* (2016, pp.88-89) conclude that these effects on inequality are generally 'modest' and 'the [declining] minimum wage made a meaningful contribution to female inequality, a modest contribution to pooled gender inequality and a negligible contribution to male lower tail inequality. In net, these estimates indicate a substantially smaller role for the US minimum in the rise of inequality than suggested by earlier work'.

Notwithstanding later examination in section 8 of possible spillover wage effects on inequality, the present study is acknowledged to be partial in concentrating on labour supply as the only endogenous response. Since policy reforms such as legislated minimum wages can be expected to affect the supply of low-wage labour, it is important to be aware of the potential for this type of response to modify distributional results obtained from fixed labour supply models. A more comprehensive evaluation would obviously need to take account of these other considerations.

The present results explicitly seek to capture the *ceteris paribus* effects of labour supply responses and are likely to represent the maximum possible redistributive effects, since other omitted factors can be expected to operate in the opposite direction. For example, increases in the minimum wage modelled here tend to increase the labour supply of low-wage workers, at both intensive and extensive margins. This can be expected to be inequality-reducing, *ceteris paribus*. By contrast, omitted demand-side effects in the form of lower employment are less likely to be inequality-reducing and may even increase some inequality measures.

3 Minimum Wage Rates in New Zealand

New Zealand was the first country, in 1894, to enact a minimum wage law, with the first minimum wage being imposed in 1899. The main rationale provided at that time was to prevent employers from hiring children and apprentices without pay (Neumark and Wascher, 2008). However, the current objective is, to set the minimum wage, 'to protect the real incomes of low-paid workers while minimising job losses' (Ministry of Business Innovation and Employment, 2013, p. 7). There are two different minimum wage levels in New Zealand:

an adult minimum wage and a youth/training category set at 80% of the adult rate. The focus of this paper is the adult minimum wage.[4] Since 2000, the minimum wage rate is reviewed each year to ensure that levels are responsive to current economic conditions. The 2012/13 minimum wage rates are reported in Table 1, which also shows the implied weekly earnings for 40 hours per week.

Table 1: Minimum Wage Rates in 2012/13

Type of minimum wage	Wage rate per hour	Earnings: 40 hours per week
Adult	$13.50	$540
Starting-out	$10.80	$432
Training	$10.80	$432

Figure 1 compares before-tax and after-tax (net) minimum wage rates across OECD countries.[5] This shows that New Zealand sets a relatively high minimum wage compared with other OECD countries.

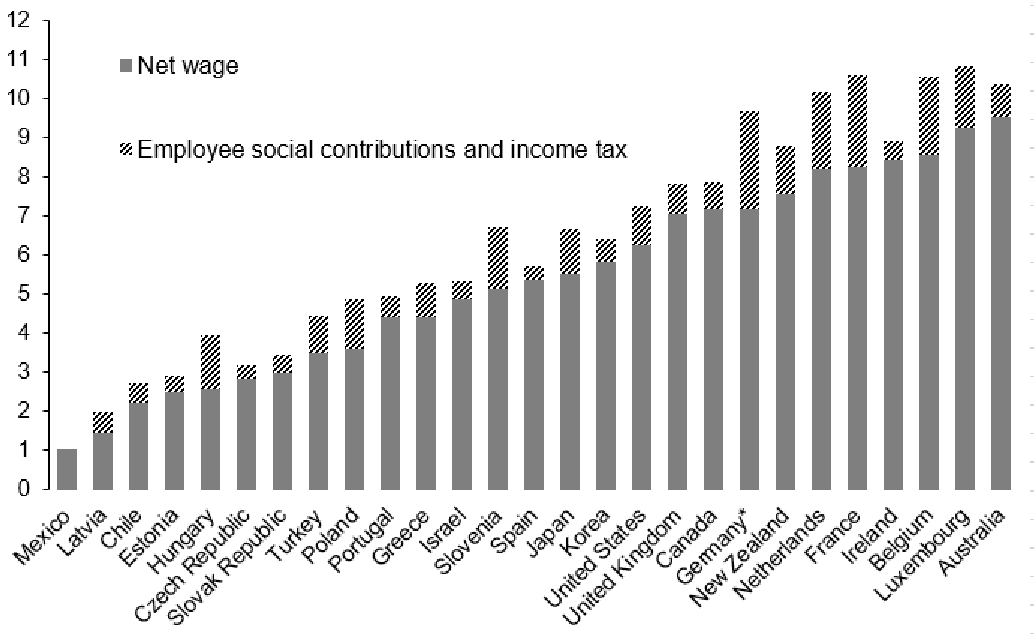

Figure 1: Hourly Minimum Wages Before and After Taxes 2012: US Dollars at PPP

[4] More details can be found in Ministry of Business Innovation and Employment (2013).

[5] The data are from OECD (2015). Germany was one of few OECD countries without a statutory minimum wage. The minimum wage was first introduced in 2015 and therefore the minimum wage level in Germany is for 2015.

4 The Model and Data

The microsimulation model used here is a version of the New Zealand Treasury's tax and transfer microsimulation model, TaxWell. This consists of two components, an arithmetic model, TaxWell-A, and a behavioural model, TaxWell-B. Both TaxWell models are based on the New Zealand Household Economic Survey (HES). The arithmetic model calculates 'impact' effects of a policy change, and the behavioural extension allows for labour supply responses in terms of hours worked.[6] This type of micrsimulation model has the advantage of capturing considerable population heterogeneity, as well as the full details of the tax and transfer system. This is important in view of the complex consequential impacts of a wage change on taxes paid and benefits received, especially since most social benefits are subject to means testing.

The behavioural model uses a discrete hours specification whereby individuals are assumed to be able to work only a restricted number of hours levels.[7] Individuals maximise a preference function in which a deterministic component is expressed in terms of net income (with positive marginal utility) and hours worked (with negative marginal utility), allowing for considerable heterogeneity. In addition, the preference function has a random component. This gives rise to the standard multinomial logit model, in which for each individual there is a probability distribution over the hours worked; see Creedy and Kalb (2006). A 'calibration' approach to simulation is used in which a series of random draws are taken from the random component, for each hours level, and sets of draws are retained for which the optimal hours correspond to the actual (discretised) hours. This means that, following a tax reform, the retained sets of error terms are used and each person has a conditional distribution of hours worked.

Analyses below are based on the Household Economic Survey for 2012/13 which is a sample of about 3,500 households. Data are collected on income by source, hours of work, and a variety of household, family, and personal characteristics. A key feature of this survey is that it identifies household and family relationships. In the following analysis, the demographic unit analysed is the 'economic family unit': this consists of one 'principal', a 'spouse' (where relevant) and relevant 'dependents', defined as children aged below 15, or below 18 and in full-time education.

A fundamental problem arises in determining a wage rate for each adult in the family, since survey respondents can report their income as either a weekly/monthly/annual amount

[6]For an introduction to behavioural microsimulation modelling, see Creedy and Kalb (2006). See also Blundell *et al.* (2008), Blundell and Shephard (2012), Capéau *et al.* (2016).

[7]These are the discrete hours, 5, 10, 15, up to an assumed maximum possible of 80 hours per week.

or as a wage rate (only around 40 per cent of the income records are directly observed wages rates) and some individuals obtain income from more than one job. The wage rates used in Taxwell are therefore constructed from data on earnings and hours, and calculated as the total weekly wage and salary earnings from individuals current job(s) divided by the number of hours worked per week. The earnings from prior jobs, self-employed work, and secondary jobs are ignored when calculating the wage rate. Simulations assume that each individual varies labour supply for only one job with a fixed gross wage.

Given that wage rates are calculated from data on earnings and hours, rather than being directly observed, this is likely to introduce measurement errors. In a small number of cases, individuals appear to be working for less than the minimum wage, yet this is known to be well-enforced in New Zealand. In carrying out the simulations reported below, any wage rates below the minimum are reset to the statutory minimum. This adjustment to the wage rate ensures that, in the calibration stage of the simulation, each individual's optimal hours of work correspond to the actual discretised hours reported: there is an implicit assumption that the reported hours are accurate.

An alternative approach would take the view that the reported incomes are assumed to be accurate, and adjustments made to reported hours worked. Although it is known that survey responses regarding hours worked are subject to greater errors than earnings, experiments showed that the simulations were very similar, probably because a relatively small number of individuals are affected by the adjustment.[8]

For those individuals in the dataset who are not working, and who therefore do not report a wage rate, it is necessary to estimate an imputed wage. Imputed wage rates are not required for certain groups since they are excluded from labour supply analysis: these are families containing at least one self-employed member, retired (aged over 65), full-time students and disabled. The imputed wages and preference functions, estimated separately for a number of demographic groups, are those obtained by Mercante and Mok (2014a, 2014b).

The tax microsimulation model was necessarily designed to examine the implications of changes to the direct tax and transfer system in New Zealand. The labour supply responses arise from changes to individuals' net incomes, and hence budget constraints, arising from a policy reform. It is therefore a relatively easy step to examine the effects of a change in the legislated minimum wage rate, for those individuals who quality for a wage rate change. Of course, except for couple families, those above the new post-reform minimum

[8]Early studies of errors in surveys of wages and hours include Duncan and Hill (1985), Rodgers, Brown and Duncan (1993). Skinner *et al* (2002) examine the bias resulting from using the ratio of earnings to hours worked; see also Brewer and De Agostini (2015).

wage experience no change in their circumstances and do not change their hours worked.[9]

5 A Policy Change

The simulations examined below are for a reform involving an increase in the New Zealand national minimum wage from $13.50 to $16.50, per hour for those aged 16 and over. In 2012, the base year for the simulation, the minimum hourly wage of $13.50 represented almost 50 per cent of the mean hourly wage (of $27.27, as reported in the *Quarterly Employment Survey*) and 65 per cent of the median hourly wage (of $20.86 per hour in the *New Zealand Income Survey*) for full time workers. The rationale for the choice of the simulated post-reform rate of $16.50 is that it would be equal to about 60 per cent of the mean hourly wage and hence it represents a substantial but plausible policy reform.

Table 2 reports demographic information on those subject to the 2012/13 minimum wage policy along with those directly affected by the simulated minimum wage increase for all households combined and for four household types: couples (with or without children), single men, single women, and sole parents. The first column of the table shows, for each group, estimates of the number of individuals subject to the $13.50 minimum wage in 2012.[10] In total, those on the minimum wage represents around 4 per cent of the total population (column 4).[11] The second column reports the number of individuals estimated to be on the minimum wage after the simulated increase to $16.50. Across all household groups, 11 per cent of workers are estimated to be on a minimum wage set at $16.50, but with a somewhat higher proportion, 17 per cent, for single women. Of course, the numbers *affected by* the simulated policy will be greater since, for couple households assumed to maximise a joint utility function, labour supply responses are possible for either or both partners even if only one is affected *directly* by the new minimum wage.

[9] For couples with a secondary earner below the new minimum wage, and given joint preference function estimation, the primary earner may change hours even if earning above the minimum wage.

[10] These estimates are based on an assumption that no worker is paid less that $13.50. That is, they ignore the distinction between the minimum wage categories in Table 1. The dataset does not provide details of the conditions that determine eligibility for the starting out and training wages rates, but numbers are likely to be small. In obtaining these numbers, and in reporting simulation results, values from the survey are 'grossed up' to population values using sample weights.

[11] A survey conducted by the Ministry of Business, Innovation and Employment (MBIE, 2013), also estimated around 4 per cent on the minimum wage in 2012. However they estimated that 84,800 out of a total of 2,227,000 jobs were paid at the minimum wage level. Differences from the absolute numbers on the minimum wage and total working population shown in Table 2 likely arise from differences in the MBIE and HES survey coverage, the focus of MBIE (2013) on *adult* minimum wage recipients only, and possible effects of 'scaling up' relatively small sample numbers to population levels.

Table 2: Number of Individuals Affected by Minimum Wage Policy

Group	Number with min wage of \$13.50 (per cent of population)	Number with min wage of \$16.50 (per cent of population)	Population
Couples	65,700	194,800	2,058,800
	(3%)	(9%)	
Single men	35,600	64,600	528,700
	(7%)	(12%)	
Single women	26,600	84,100	489,400
	(5%)	(17%)	
Sole parents	10,300	28,600	189,400
	(5%)	(15%)	
Total	138,200	372,100	3,266,300
	(4%)	(11%)	

6 Simulation Results

This section presents the simulation results for the policy change described above. First, it is of interest to examine budget constraint changes for selected family types. Examples for sole parents are shown in subsection 6.1, in view of the results discussed in subsequent sections. Some aggregate effects are examined in Subsection 6.2. The effects on inequality, social welfare and poverty are reported in Subsections 6.3, 6.4 and 6.5 respectively.

6.1 Budget Constraints

A feature of the labour supply responses of sole parents (consisting largely of single mothers) can be seen from the budget constraints for two hypothetical cases, shown in Figures 2 and 3. These show the pre- and post-reform budget constraints for two families of different sizes, indicating how the minimum wage rise can increase net incomes in the relatively high hours range. At lower hours levels families are generally entitled to welfare benefits such as Domestic Purposes Benefit and family tax credits, subject to various abatement rates, such that any minimum wage change has little effect on the budget constraint.

The pre- and post-reform budget constraints start diverging at the 30 hours level when benefits are no longer available for these families. Despite using a discrete hours modelling approach, these budget constraints illustrate the net incomes over all work hours. An important feature of the budget sets is that they have non-convex ranges: once the benefits are abated, the effective marginal tax rate facing sole parents falls, so that the budget line becomes steeper. An implication of such non-convexities is that small changes in net

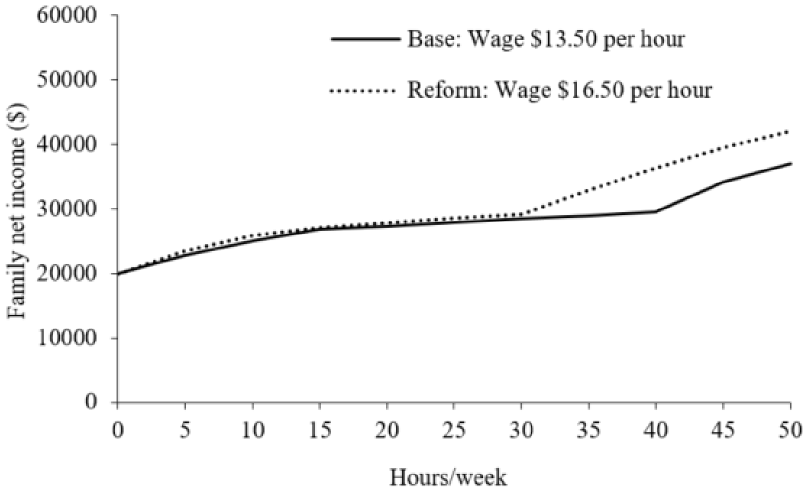

Figure 2: Budget Constraints: Sole Parent with One Child

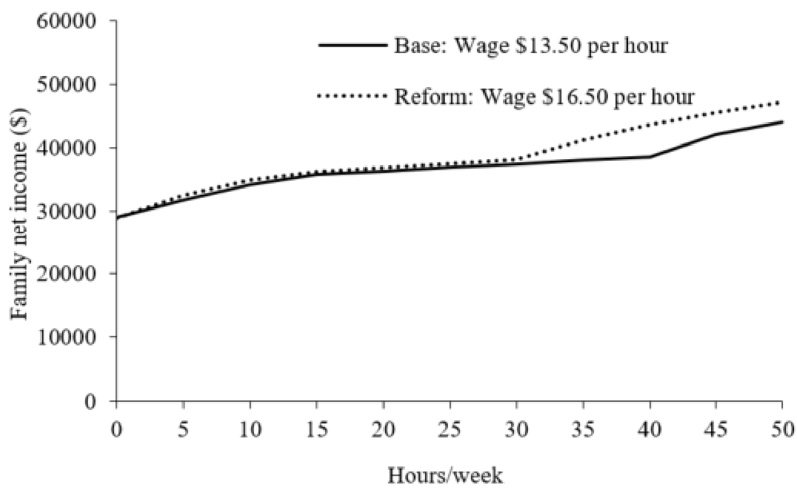

Figure 3: Budget Constraints: Sole Parent with Two Children

incomes can lead to relatively large jumps in optimal hours worked: this is seen from the transition matrices reported in the following subsection.

6.2 Revenue and Labour Supply Effects

Table 3 provides a summary of some aggregate changes in net tax revenue for four demographic groups and for all families combined. In obtaining these aggregates, sample weights are used to 'gross up' the sample to total population values. The table reveals that, in the absence of any behavioural responses, the model suggests an increase in tax revenue (row 2) of $375.5 million from the approximately 22 per cent rise in the minimum wage. This reflects the higher taxes paid on increased earnings, combined with associated reductions in means-tested welfare benefit payments. However, when labour supply effects are modelled, the net revenue effect from row 1 is about three times larger at $1,170.2 million, as the additional labour supply induced by higher minimum wage levels generates additional net tax revenue.[12]

Table 3: Aggregate Net Revenue Effects

	Couples	Single		Sole	Total
		male	female	parents	
Without labour supply responses:					
Increase in net revenue ($m)	188.5	88.4	63.5	35.1	375.5
With labour supply responses:					
Increase in net revenue ($m)	251.0	94.0	332.9	492.5	1,170.2
Per cent of increase in net revenue	21	8	29	42	100
Per cent of sample	46	24	22	8	100

Table 3 also shows that couples represent just under half the sample but contribute 21 per cent of the net revenue increase, while sole parents contribute 42 per cent of the net revenue increase, despite forming only 8 per cent of the sample. Single males and females combined are also just under half of the total sample (46 per cent) and contribute 37 per cent of the net revenue increase.

The labour supply responses are summarised for three demographic groups consisting respectively of single females, sole parents and married women by the transition matrices

[12] This $1,170 million net revenue rise represents about a 13 per cent increase in pre-reform net revenue of $9,153 million, compared with a 4 per cent increase with no labour supply responses. All net revenue estimates ignore the additional fiscal cost of minimum wage increases paid to public sector workers since the dataset does not separately identify public sector employment. While this would need to be included in any comprehensive estimate of net fiscal impacts, it will have little effect on 'fiscal equivalent' policy comparisons below since the sectoral composition of minimum wage employment is not expected to be substantially affected.

shown in Tables 4, 5 and 6. These show the conditional probabilities (as percentages) of movement between discrete hours levels, where movement is from rows to columns. The final row and column of each matrix shows the percentage of the group working at each discrete hours level (post- and pre-reform respectively). In these tables an entry of '-' indicates that no transitions arise, whereas an entry of zero indicates the negligible proportion of transitions.

The main feature of these matrices is that the distribution of work hours following the minimum wage change, conditional on working a particular hours level before the change, are multi-modal and reflect the 'jumps' in hours worked arising from the non-convexity of the budget sets, discussed above. The first row of Table 4 shows that almost six per cent of single females, who do not work before the change in the minimum wage, wish to supply positive hours of work post-reform. However, the fact that none of these wishes to work less than 25 hours reflects the high fixed cost of working in the preference functions of single females. The probabilities of increasing hours worked, for single females, is higher for those working 20 hours before the reform as a result of the minimum wage change: beyond this there is a very small probability of increasing work hours supplied (the diagonal of the matrix is almost 100 per cent).

For sole parents, Table 5 shows that there is a much higher probability of supplying positive hours after the reform, with low hours levels also being supplied (in contrast to single females). However, for those already working 5 and 10 hours per week, labour supply increases are to 35 hours and above; again reflecting the non-convexity of budget sets. The small extent of reductions in labour supply (shown by entries below the main diagonal) arise for those who can experience a net income increase along with a reduction in hours worked: this possibility is clearly indicated by the kind of budget line shown above. In the view of the fact that the only people whose labour supply may possibly change are those working at, or just above, the initial minimum wage rate, the only case which is not affected is of single women initially working 50 hours. This suggests that (except for this group) those working on minimum wages are spread across the full range of discrete hours levels available.

Table 6 reports the transition matrix for married women, which may be compared with that for single women, in Table 4. A larger proportion of married women supply zero work hours before the minimum wage increase (45.8 per cent compared with 53.4 per cent). Before the minimum wage change, 16.2 per cent of single women supply from 5 to 30 hours, but the corresponding figure for married women is 21.9 per cent. Married women display proportionately more reductions in hours of work supplied, compared with single women (below the main diagonal).

Table 4: Single Female Labour Supply Transitions: From Rows to Columns (Per cent)

Labour supply in hours per week												
	Post-reform											
Pre-reform	0	5	10	15	20	25	30	35	40	45	50	Total (%)
0	94.2	-	0	0	0	0.2	0.6	0.9	1.4	1.5	1.2	53.4
5	-	98.4	-	-	-	-	0.3	0.3	0.5	0.2	0.3	1.5
10	-	-	-	-	0	0.3	0.8	1.5	2.1	1.8	1.7	3.9
15	-	-	-	92.9	-	0.2	0.4	1.4	1.5	1.5	2.1	3.1
20	-	-	-	-	82.5	0.4	1.3	2.9	3.8	5.7	3.4	1.9
25	-	-	-	-	-	98.6	0.3	0.1	0.3	0.2	0.4	1.5
30	-	-	-	-	-	-	96.6	0.4	0.8	0.8	1.4	4.3
35	-	-	-	-	-	-	0.1	98.1	0.5	0.6	0.7	5.2
40	-	-	-	-	-	-	0	-	99.5	0.3	0.2	15.3
45	-	-	-	-	-	-	-	-	-	99.9	0.1	4.6
50	-	-	-	-	-	-	-	-	-	-	100	5.3
Total (%)	50.3	1.5	3.6	2.9	1.6	1.6	4.6	5.7	16.2	5.7	6.3	100

6.3 Inequality Effects

This subsection examines the effects on inequality of the minimum wage increase, using the Atkinson inequality measure, $A(\varepsilon)$, where ε is the degree of relative inequality aversion.[13] Inequality is measured by the proportional difference between the arithmetic mean, $\bar{y}$, and the equally distributed equivalent value, y_{ede}, where the latter is the value which, if obtained by everyone, gives the same social welfare as the actual distribution; hence $A(\varepsilon) = 1 - y_{ede}/\bar{y}$. Using an additive welfare function based on constant relative inequality aversion, ε, of the form:

$$W = \frac{1}{1-\varepsilon} \sum_{i=1}^{n} y_i^{1-\varepsilon} \tag{1}$$

the equally distributed equivalent value, y_{ede}, is in general, for a set of values y_i, for $i = 1, \ldots, n$, equal to:

$$y_{ede} = \left(\frac{1}{n} \sum_{i=1}^{n} y_i^{1-\varepsilon} \right)^{1/(1-\varepsilon)} \tag{2}$$

[13] Inequality effects measured using the Gini index are also reported in section 7, where they are compared with results from an alternative policy of increasing social welfare benefits.

Table 5: Sole Parent Labour Supply Transitions: From Rows to Columns (Per cent)

Labour supply in hours per week												
	Post-reform											
Pre -reform	0	5	10	15	20	25	30	35	40	45	50	Total (%)
0	81	0.2	0.5	0.3	0.4	0.5	0.6	3.2	5.4	4.5	3.6	62.6
5	-	89.4	0.2	-	-	-	-	1.9	3	2.8	2.7	3.1
10	-	-	90.7	-	-	-	-	1.6	3.1	1.9	2.6	5.3
15	-	0.2	0.3	84.6	0.4	0.3	0.1	3.3	5.5	3	2.5	3.3
20	-	-	-	-	94	-	-	1.7	2.2	1.2	0.9	2.4
25	-	-	-	-	-	89.4	0.1	0.8	3.7	4.1	1.9	2.8
30	-	-	-	-	-	-	92.9	2.6	2	1	1.5	4
35	-	-	-	-	-	-	-	100	-	-	-	3.1
40	-	-	-	-	-	-	-	0.2	99.8	-	-	8.2
45	-	-	-	-	-	-	-	0.1	0.4	99.6	-	1.9
50	-	-	-	-	-	-	-	0.1	-	-	99.9	3.2
Total (%)	50.7	2.9	5.2	2.9	2.5	2.8	4.1	5.5	12.2	5.2	5.9	100

Table 6: Married Women Labour Supply Transitions: From Rows to Columns (Per cent)

Labour supply in hours per week												
	Post-reform											
Pre-reform	0	5	10	15	20	25	30	35	40	45	50	Total (%)
0	99.7	0	0	0	0	0	0	0	0.1	0	0	45.8
5	-	98.9	-	0	0	0.1	0.2	0.2	0.1	0.3	0.2	1.6
10	0.1	-	98.4	0	0	0.1	0.2	0.3	0.3	0.3	0.2	2.8
15	-	-	-	98.9	0	0	0.1	0.2	0.2	0.2	0.3	2.9
20	0.1	-	0	-	98.7	0.1	0.1	0.2	0.2	0.3	0.2	4.0
25	0	-	0	-	-	99.3	0.2	0.1	0.2	0.1	0.1	3.9
30	0.1	0	0	0	0	0	99.3	0.1	0.1	0.1	0.1	6.7
35	0.1	0	-	0	0	0	0.1	99.3	0.1	0.2	0.1	5.7
40	0.2	0	0	0	0	0.1	0.1	0.1	99.4	0.1	0.1	17.8
45	0	-	-	-	0	-	-	0	0.1	99.8	0.1	3.9
50	0.1	-	-	-	0	0.1	0.1	0.1	0.1	0.2	99.4	4.9
Total (%)	45.7	1.5	2.8	2.9	4	3.9	6.7	5.7	17.8	4	5	100

As ε is increased, the weight attached to lower incomes is increased, and the absolute value of $A(\varepsilon)$ increases. The ability to compare results for different degrees of relative inequality aversion is seen below to provide useful insights into the redistributive effects of a minimum wage increase.

Results are obtained for two different welfare metrics: these are in terms of net income and 'money metric utility', where the latter allows for the utility from leisure. In each case, the results are based on values per adult equivalent person, using the following parametric equivalence scales. The adult equivalent size of the household, m, is defined as:

$$m = (n_a + \theta n_c)^\gamma \tag{3}$$

where n_a and n_c refer to the number of adults and children in the household, respectively. Here θ and γ are parameters reflecting the relative cost of a child and economies of scale, respectively (see Creedy, 2017). The results shown below assume there are no economies of scale ($\gamma = 1$) but set the weight attached to children, θ, at 0.6.

Table 7 reports results for the inequality of net income (the left-hand block) and money metric utility (the right-hand block) per adult equivalent person. The unit of analysis is the individual. Results are obtained using the 'pseudo distribution' method, introduced by Creedy *et al.* (2004, 2006), to deal with the fact that, post-reform, each person has a probability distribution over the available set of discrete working hours. Given the significance of children in these calculations, the table presents results for couples split into those with and those without dependents, but combines single males and females.

The left-hand block of the table shows that the redistributive effect of the minimum wage increase is small, measured by the change in the Atkinson measure of net income per adult equivalent person. Furthermore, the percentage reduction falls as inequality aversion increases. For higher values of ε, inequality is seen to increase for some of the demographic groups, and for all groups combined when $\varepsilon = 2$. The increase in inequality resulting from the minimum wage increase, for the higher ε values, is highest for sole parents. This reflects the fact that the minimum wage increase is producing more inequality in the very lowest ranges of the distribution of net income, but less inequality in the somewhat higher ranges.

This is important in the case of sole parents, for whom the participation rate is lowest (the proportion supplying zero hours is highest, see Table 5). Hence, when the higher incomes are given much less weight, with high ε, the changes at the bottom of the distribution dominate, and the policy becomes inequality-increasing. It was mentioned earlier that some low-income people are secondary earners in relatively higher-income households. Nevertheless, within the demographic groups consisting only of couples (with and without children), the minimum wage increase is inequality reducing even for the high inequality aversion parameter.

Table 7: Atkinson Inequality Measures for Demographic Groups: Net Income and Money Metric Utility Per Adult Equivalent Person

	Net income			Money metric utility		
	Before	After	% Change	Before	After	% Change
$\varepsilon = 0.1$						
Couple	0.0168	0.0164	-1.89	0.0228	0.0227	-0.28
Couple+dependents	0.0149	0.0146	-1.95	0.0248	0.0247	-0.58
Single	0.0264	0.0252	-4.54	0.0290	0.0288	-0.73
Sole parents	0.0094	0.0090	-4.19	0.0117	0.0116	-0.45
All	0.0200	0.0193	-3.45	0.0255	0.0254	-0.52
$\varepsilon = 0.2$						
Couple	0.0334	0.0328	-1.84	0.0458	0.0457	-0.24
Couple+dependents	0.0291	0.0286	-1.93	0.0477	0.0474	-0.56
Single	0.0522	0.0499	-4.32	0.0581	0.0577	-0.62
Sole parents	0.0185	0.0178	-3.79	0.0228	0.0227	-0.39
All	0.0395	0.0381	-3.37	0.0502	0.0500	-0.47
$\varepsilon = 0.5$						
Couple	0.0824	0.0810	-1.65	0.1156	0.1155	-0.10
Couple+dependents	0.0692	0.0679	-1.88	0.1083	0.1077	-0.50
Single	0.1273	0.1227	-3.59	0.1473	0.1468	-0.31
Sole parents	0.0441	0.0429	-2.57	0.0539	0.0538	-0.20
All	0.0951	0.0922	-3.07	0.1212	0.1208	-0.31
$\varepsilon = 0.8$						
Couple	0.1302	0.1283	-1.44	0.1860	0.1860	-0.03
Couple+dependents	0.1068	0.1049	-1.78	0.1629	0.1623	-0.42
Single	0.2042	0.1987	-2.71	0.2435	0.2434	-0.02
Sole parents	0.0673	0.0664	-1.37	0.0825	0.0824	-0.02
All	0.1485	0.1445	-2.70	0.1907	0.1904	-0.16
$\varepsilon = 1.4$						
Couple	0.2226	0.2204	-0.97	0.3234	0.3241	0.22
Couple+dependents	0.1884	0.1858	-1.38	0.2826	0.2820	-0.21
Single	0.4342	0.4323	-0.45	0.5197	0.5213	0.31
Sole parents	0.1077	0.1087	0.87	0.1349	0.1353	0.30
All	0.2763	0.2721	-1.50	0.3573	0.3577	0.11
$\varepsilon = 2.0$						
Couple	0.3110	0.3094	-0.50	0.4466	0.4480	0.31
Couple+dependents	0.3563	0.3550	-0.37	0.5165	0.5168	0.05
Single	0.8711	0.8741	0.34	0.9159	0.9167	0.09
Sole parents	0.1418	0.1458	2.84	0.1844	0.1854	0.55
All	0.6506	0.6527	0.31	0.7577	0.7587	0.13

Table 7 also shows corresponding results for the welfare metric defined in terms of money metric utility. This is calculated following the approach suggested by Creedy, Hérault and Kalb (2011), to deal with highly nonlinear budget constraints and the random utility component. Unlike the use of net income, this welfare metric allows for changes in leisure. For all degrees of inequality aversion, and for all demographic groups, the reduction in inequality is considerably lower than for net income. In addition, for the higher values of ε, 1.4 and 2.0, all demographic groups experience a small increase in inequality with the single exception of couples with dependents.

This is an important result since it suggests that the reductions in inequality as conventionally applied to a household income measure (in this case, incomes after direct taxes and benefits) are substantially associated with reduced leisure by households which increase their labour supply. When this reduced leisure is suitably valued, the minimum wage policy generally has a negligible impact on inequality, and can in some cases increase inequality for some inequality aversion parameters and household types.

These relative small effects on inequality of net incomes or utility are obtained with endogenous labour supply responses. But how important are these *ceteris paribus* labour supply responses for inequality outcomes? In the Appendix, the inequality results above are compared with equivalent measures but based on a fixed labour supply assumption. It is shown there that inequality reductions associated with the minimum wage increase are even smaller in this case. However, allowing for potential labour supply effects of an increase in the minimum wage matters substantively in the calculation of inequality changes. For example, for all household types combined, the percentage change in the Atkinson inequality measure (for $\varepsilon = 0.5$, 0.8) based on net incomes becomes -0.77 ($\varepsilon = 0.5$) and -0.56 ($\varepsilon = 0.8$) in the fixed labour supply case, compared with -3.07 and -2.70 respectively in Table 7. Unsurprisingly, differences between the fixed and variable labour supply cases for the inequality of money metric utility are much smaller, because this incorporates changes in the value of leisure.

6.4 Social Welfare Function Evaluation

The previous subsection showed that the simulated increase in the minimum wage produces, for some demographic groups, an increase in inequality for higher degrees of inequality aversion, and an increase for all groups in the case of $\varepsilon = 2.0$. However, it is well-known that the Atkinson inequality measure is associated with a social welfare (or evaluation) function whose abbreviated form can be conveniently expressed in terms of the inequality and mean of the distribution. For a variable with arithmetic mean, μ, and Atkinson inequality, $A(\varepsilon)$, abbreviated social welfare, $\widetilde{W}$, takes the form:[14]

$$\widetilde{W} = \mu \left(1 - A\left(\varepsilon\right)\right) \tag{4}$$

This shows a clear trade-off between ‘equity and efficiency’, that is, the extent to which an increase in inequality (a reduction in equity) can be compensated by an increase in the arithmetic mean (an increase in efficiency). In the cases where inequality increases, the higher minimum wage is not benefiting non-workers, while it is helping those who are working to obtain higher net incomes and higher utility (in most cases, even when some leisure is sacrificed). The higher averages may compensate, in terms of ‘social welfare’ for the higher inequality. Table 8 reports values of the abbreviated welfare function using both net income and money metric utility per adult equivalent person, for each demographic group. All changes in abbreviated social welfare are positive in this case.

Table 8: Percentage Welfare Changes: Money Metric Utility and Net Income

Group	Couple	Couple + dependent	Single	Sole parents	All
Net Income					
$\varepsilon = 0.1$	0.96	0.77	3.16	6.62	1.87
$\varepsilon = 0.2$	0.99	0.80	3.28	6.65	1.93
$\varepsilon = 0.5$	1.08	0.88	3.57	6.70	2.12
$\varepsilon = 0.8$	1.15	0.95	3.75	6.68	2.27
$\varepsilon = 1.4$	1.21	1.06	3.39	6.46	2.38
$\varepsilon = 2.0$	1.16	0.95	0.67	6.07	1.20
Money Metric Utility					
$\varepsilon = 0.1$	0.50	0.33	1.10	0.75	0.60
$\varepsilon = 0.2$	0.51	0.34	1.12	0.75	0.61
$\varepsilon = 0.5$	0.51	0.38	1.13	0.75	0.62
$\varepsilon = 0.8$	0.49	0.40	1.08	0.74	0.62
$\varepsilon = 1.4$	0.39	0.40	0.74	0.69	0.52
$\varepsilon = 2.0$	0.25	0.26	0.08	0.61	0.16

6.5 Poverty Effects

This subsection considers the question of whether an increase in the minimum wage reduces poverty. Three commonly reported poverty measures are derived from the Foster, Greer and

[14] This has the further advantage that abbreviated welfare, $\widetilde{W}$ remains positive, unlike W, for values of $\varepsilon > 1$.

Thorbecke (1984) family. Letting P_α denote the poverty measure for parameter, α, then:

$$P_\alpha = \frac{1}{N} \sum_{y_i \leq y_p} \left(\frac{y_p - y_i}{y_p} \right)^\alpha \tag{5}$$

where y_i is (positive) income for individual i, y_p is the (income) poverty line, and N is the total number of people in the population.[15] When $\alpha = 0$, this measure reflects the headcount poverty index, P_0, equal to the proportion of the population falling below the poverty line. The measure, P_1, reflects the incidence and the average income of those falling below the poverty line, and P_2 allows, in addition, for inequality (measured by the coefficient of variation) of those in poverty. The former captures the proportionate poverty income gap, $(y_p - y_i)/y_p$, while the latter is based on the square of the poverty gap index. P_2 is therefore a distribution-sensitive poverty measure which penalizes greater inequality *among* the poor.

The choice of the poverty line, y_p, is obviously crucial. If a relative poverty line is chosen (setting y_p as a fixed percentage of, say, median income), then an increase in the minimum wage has the effect of raising the poverty line. This means that it is possible for poverty to increase, despite a reduction in inequality. For present purposes it was therefore decided to examine two cases. First, the line was set at a fixed absolute value in both pre- and post-reform cases and, second, it was set in relation to median adult-equivalent income. Two ratios, 50 per cent and 40 per cent of median income per adult equivalent person, were used for the relative poverty lines. The absolute poverty measure was set in relation to the pre-reform median income for all demographic groups combined.

Table 9 shows results for the three P_α indices for both absolute and relative poverty measures, in each case using 40 per cent and 50 per cent of median income as the base. In all cases four separate household groups are reported in addition to the total population. The results suggest, first, that for all households combined the increase in the minimum wage reduces poverty using P_0 or P_1 measures: reductions range from -0.18 per cent to -7.09 per cent. These reduction are less pronounced, indeed negligible, once the distribution-sensitive measure, P_2, is used: there is a zero poverty change for P_2 using 40 per cent of median income and -0.03 per cent using 50 per cent of median income.

However, for relative poverty, even for all households combined, there are substantially different poverty changes depending on whether P_0 or P_1 is used and the percentage threshold of the median income. For example, using P_0, relative poverty is reduced marginally using 50 per cent of median income (-0.90 per cent) but increases (+4.49 per cent) using 40

[15] Well-known problems estimating values of P_α where some $y_i < 0$ are not relevant here since all such individuals were dropped from the sample.

Table 9: Increase in Minimum Wage: Alternative Poverty Measures

		Absolute		Relative	
	Before	After	% diff.	After	% diff.
40 per cent of Median income					
Poverty line	\$162.13	\$162.13		\$166.83	
$\alpha = 0$ (Headcount)					
Couple	0.0248	0.0248	0.00	0.0255	2.82
Couple + dependents	0.0382	0.0374	-2.09	0.0424	10.99
Single	0.1219	0.1200	-1.56	0.1209	-0.82
Sole parents	0.0147	0.0122	-17.01	0.0218	48.30
All	0.0512	0.0502	-1.95	0.0535	4.49
$\alpha = 1$ (Poverty gap)					
Couple	0.0389	0.0389	0.00	0.0385	-1.03
Couple + dependents	0.0599	0.0599	0.00	0.0593	-1.00
Single	0.9190	0.9160	-0.33	0.0924	0.54
Sole parents	0.0025	0.0023	-8.00	0.0027	8.00
All	0.0545	0.0544	-0.18	0.0543	-0.37
$\alpha = 2$ (Incl. within-poor inequality)					
Couple	0.2715	0.2715	0.00	0.2586	-4.75
Couple + dependents	1.1340	1.1340	0.00	1.0743	-5.26
Single	0.2403	0.2402	-0.04	0.2320	-3.45
Sole parents	0.0008	0.0008	0.00	0.0009	12.50
All	0.5386	0.5386	0.00	0.5117	-12.32
50 per cent of Median income					
Povery line	\$202.66	\$202.66		\$208.53	
$\alpha = 0$ (Headcount)					
Couple	0.0489	0.0482	-1.43	0.0492	0.61
Couple + dependents	0.0735	0.0673	-8.44	0.0701	-4.63
Single	0.1783	0.1701	-4.60	0.1766	-0.95
Sole parents	0.1508	0.1274	-15.52	0.1559	3.38
All	0.1002	0.0931	-7.09	0.0993	-0.90
$\alpha = 1$ (Poverty gap)					
Couple	0.0386	0.0385	-0.26	0.0388	0.52
Couple + dependents	0.0588	0.0585	-0.51	0.0588	0.00
Single	0.1018	0.1006	-1.18	0.1027	0.88
Sole parents	0.0162	0.0140	-13.58	0.0176	8.64
All	0.0580	0.0573	-1.21	0.0584	0.69
$\alpha = 2$ (Incl. within-poor inequality)					
Couple	0.1875	0.1875	0.00	0.1793	-4.37
Couple + dependents	0.7469	0.7469	0.00	0.7086	-5.13
Single	0.1886	0.1883	-0.16	0.1835	-2.70
Sole parents	0.0033	0.0029	-12.12	0.0037	12.12
All	0.3647	0.3646	-0.03	0.3476	-4.69

per cent of median income. These directions are reversed using P_1, to +0.69 per cent and -0.37 per cent respectively.

7 Comparisons with Tax and Transfer Policy

Results in previous sections suggested that, in view of the composition of household incomes, a policy of increasing the minimum wage has a relatively small effect on the inequality of income per adult equivalent person. Indeed, it was shown that for high aversion to inequality (greater weight placed on low incomes in the social evaluation function), a minimum wage increase can actually increase overall inequality. Thus the minimum wage policy was found to be not particularly well targeted at this objective. This largely reflected the fact that many low-wage earners are secondary earners in higher-income households, while many other low-income households have no wage earners at all.

This section considers how the inequality and poverty changes associated with (changes to) a minimum wage policy can be compared with an alternative commonly used policy tool with similar redistributional objectives, namely the use of fiscal transfers via the tax-benefit system. In comparing a minimum wage increase with an alternative involving a change in the tax-transfer system, it is known that there are also 'target inefficiencies' in the benefit structure. That is, many benefit recipients are not in the lowest income groups. This is mitigated to some extent by the use of abatement rates, though some transfer payments (for example, family tax credits in New Zealand) can be received by relatively high-income households.

It is well known that the design of a tax-transfer system, seeking to achieve redistribution while subject to the constraints imposed by adverse incentive effects, presents a considerable challenge. Instead of considering a wide range of complex changes involving benefit levels and abatement rates, the present analysis concentrates on a simple comparison involving a policy of increasing all basic benefit levels (leaving abatement rates, along with income tax rates and tax credits, unchanged). While it is recognised that this may not necessarily be strongly inequality-reducing, given that many higher-income households also benefit from the change, it is useful to compare two clearly-defined practical policy alternatives.[16]

[16] Indeed, a more comprehensive search for a policy that reduces inequality and poverty, subject to the usual constraints, may produce some combination of minimum wage and tax-transfer reforms.

7.1 Defining Policy Equivalence

For two alternative fiscal policy reforms, such as different benefit or tax system parameter changes, a natural comparison involves choosing two revenue-neutral, or deficit-neutral, reforms. But for the two policies examined here (a minimum wage increase versus a benefit increase) there is no such fiscal equivalence. This raises the question of whether comparable minimum wage and benefit reforms can be selected that are not arbitrarily chosen?[17]

One approach is to consider a comparison that involves an 'equivalent cost' of achieving the reduction (where relevant) in inequality. This is complicated by the fact that the imposition of a higher minimum wage imposes those costs on employers rather than the public purse (except for public sector minimum wage employees, and of course final incidence may differ where this also leads to price changes), while the government obtains a net revenue gain from the increase in income tax revenue and the reduction in benefit payments (since labour supply generally increases). By contrast, in the case of a benefits change, there is an obvious financial cost to the government, arising from higher expenditures and labour supply (and thus tax revenue) reductions. Additional complications arise since any change that is not revenue-neutral is therefore merely a partial policy change.

A possible comparison involves asking the question: what if the government were to finance the increase in the minimum wage from tax revenue? This net cost – a form of 'wage subsidy' in excess of the net revenue increase from higher taxable incomes and abated benefits – could then be compared with an equal-sized direct fiscal cost of a tax-transfer change? Of course, this thought experiment involves a different incidence of the minimum wage policy relative to an actual policy, by shifting it from employers (and potentially employees and consumers) to government. In turn, the fiscal cost of this wage subsidy would need to be raised by some other tax or expenditure change. However, this aspect also applies to the alternative tax-transfer policy. To the extent that an actual minimum wage increase is not funded by government, the fiscal cost estimate provides a measure of the potential fiscal gain to the government compared to a net revenue equivalent tax-benefit policy change.

7.2 Measuring the Minimum Wage Subsidy

How can the cost of the minimum wage subsidy be measured? Suppose the increase in the minimum wage is $\Delta w_{\min}$, and hours worked post-change (omitting individual subscripts)

[17] Atkinson *et al.* (2017) also compare the inequality effects of a minimum wage and tax-transfer policy change using a non-behavioural microsimulation model. However, the basis for their comparisons is arbitrary since it involves examining two specific, independent policy reforms previously proposed by Atkinson (2015).

are denoted by h.[18] If there are initially $N_{\min}$ people receiving the minimum wage, then the implicit subsidy for this subset of workers is given by $S_{\min} = N_{\min}\overline{h}_{\min}\Delta w_{\min}$, where $\overline{h}_{\min}$ is the arithmetic mean value of h, averaged over the $N_{\min}$ wage earners.

In addition, there may be another group of, say N_{NW}, individuals who were not working before the policy change but who, given the higher minimum wage, choose to supply positive hours. In this case the full value of the new minimum wage, $w_{\min}$, rather than $\Delta w_{\min}$, would be paid by the government and the implicit subsidy for this group is thus given by $S_{NW} = N_{NW}\overline{h}_{NW}w_{\min}$, where $w_{\min}$ is the new (higher) minimum wage and where $\overline{h}_{NW}$ is the arithmetic mean number of hours worked by the new N_{NW} wage earners.

There are also potentially some workers, N_A, with initial wage rates, w, that were above the pre-change minimum wage, but below the post-change minimum, $w_{\min}$. The implicit subsidy for this third group can be measured by $S_A = N_A(\overline{h}_A w_{\min} - \overline{y}_A)$, where $\overline{y}_A$ is arithmetic mean earnings averaged over the N_A individuals, and $\overline{h}_A$ is the arithmetic mean hours worked post-reform by this group.

Considering all three affected groups together, the total implicit subsidy, S, associated with the three groups is thus:

$$\begin{aligned} S &= S_{\min} + S_{NW} + S_A \\ &= N_{\min}\overline{h}_{\min}\Delta w_{\min} + N_{NW}\overline{h}_{NW}w_{\min} + N_A(\overline{h}_A w_{\min} - \overline{y}_A) \end{aligned} \tag{6}$$

Equation (6) respectively captures the subsidy to: (i) those already on the minimum wage before the reform; (ii) those not earning before the reform but who enter employment and earn the new minimum wage after reform and; (iii) those whose pre-reform wages were between the pre- and post-reform wage minima and whose wages are increased to the new (higher) minimum after reform.

An alternative decomposition of the implicit subsidy to that given in (6) could consider the implicit subsidy for fixed labor supply and the additional subsidy associated with any policy-induced changes in labour supply that involve payment of the minimum wage. The first and third terms in (6) involve combinations of the two since $\overline{h}_{\min}$ and $\overline{h}_A$ measure average *post-reform* hours, while $\overline{h}_{NW}$ measures both the post-reform hours average and the average hours *change* for this group of previously non-working individuals.

Using the microsimulation model to estimate the size of the wage subsidy from the \$3 minimum wage increase, using (6), identifies the gross annual cost as \$1,693 million, equivalent to an average of around \$87 per week per minimum wage recipient, after the

[18] For present purposes, the hours worked after the policy change can be calculated as, for each person, the expected value of the conditional hours distribution (that is, conditional on having a pre-reform optimal hours equal to observed discretised hours).

reform. However, additional tax revenues (plus lower benefit payments) of the policy are estimated at $1,170 million.[19] Hence the net cost to the government of the simulated minimum wage increase would be $523 million.

To identify an equivalent benefit reform, simulations therefore consider uniform increases in all basic levels of welfare benefits (such as Domestic Purposes Benefit, Unemployment Benefit and Sickness Benefit) with a net cost of $523 million. Simulating a number of benefit level increases (in increments of $0.50) identifies that raising all benefit levels by $12.50 has a net fiscal cost of $525 million (after allowing for labour supply responses). The inequality and poverty impacts of this 'fiscally equivalent' benefit policy change are therefore examined below.

[19] This net revenue gain to the government budget from the minimum wage increase is substantially due to the labour supply effects captured in the model. With a fixed labour supply assumption the net revenue gain is only $375 million. As noted earlier, of necessity this net revenue comparison excludes the additional minimum wage costs of public sector workers. However, in this policy comparison thought experiment where minimum wage increases for *all workers* are being financed from the government budget, this is not a concern.

7.3 Inequality and Poverty Impacts

Table 10 shows Gini and Atkinson inequality measures for net incomes associated with both the \$3 minimum wage increase and the \$12.50 benefit increase. Considering first the Gini measure, the top panel of Table 10 indicates that across the whole sample inequality reductions due to the benefit increase are actually less than with the minimum wage policy: the Gini reductions are -0.55 per cent and -1.72 per cent respectively. Decomposing this result by household type confirms that only for sole parent households (those who gain most from the benefit policy and least from labour market wage policies) is the Gini reduction associated with the benefit increase greater than that resulting from the minimum wage increase (-2.27 per cent versus +0.70 per cent). For the four other household types, the minimum wage policy is unambiguously more inequality-reducing.

Results for the Atkinson inequality index in Table 10 are consistent with the Gini evidence. Except for the highest inequality aversion parameter case ($\varepsilon = 2$), for all household types combined, inequality reductions are greater with the minimum wage policy, though the percentage reductions tend to become more similar the higher the value of ε considered. Results across household types again confirm that it is only for sole parents that there is consistent evidence that a benefit increase would be more inequality-reducing. Indeed, unlike the minimum wage case, for sole parents the benefit increase is inequality-reducing at all inequality aversion parameter values considered.

Turning to poverty reductions, Table 11 provides comparisons between the two policies using the 50 per cent of median income threshold for the three poverty measures considered previously: $\alpha = 0, 1, 2$. Similar results (not shown) were obtained using 40 per cent of median income. These results generally lead to the opposite conclusion regarding the preferred policy, compared with the inequality comparisons in Table 10. That is, they suggest that the benefit increase policy typically has a bigger poverty-reducing effect than the minimum wage increase. For example, for all households combined using the headcount measure, absolute and relative poverty are reduced by around seven per cent and one per cent respectively via the minimum wage policy. However, both absolute and relative poverty fall by around 15 per cent if benefits are raised. Across the various poverty measures, only for relative poverty and when $\alpha = 2$ is this conclusions reversed.

Examining the outcomes by household types reveals that the larger reductions in poverty, using an increase in benefits, generally apply across all household types, but especially to sole parent households. Indeed, while the minimum wage policy increases poverty for sole parents across all three values of α, the benefit increase policy substantially reduces poverty in all cases.

Table 10: Comparing Inequality Impacts: Minimum Wages Change versus Benefit Changes

Policy:	Min. wage change			Benefit change	
	Before	After	% Change	After	% Change
Gini					
Couple	0.3329	0.3294	-1.06	0.3324	-0.18
Couple+dependents	0.3087	0.3053	-1.11	0.3084	-0.11
Single	0.4156	0.4062	-2.27	0.4128	-0.69
Sole parents	0.2300	0.2316	0.72	0.2248	-2.24
All	0.3609	0.3547	**-1.72**	0.3589	**-0.55**
Atkinson: $\varepsilon = 0.2$					
Couple	0.0334	0.0328	-1.84	0.0332	-0.47
Couple+dependents	0.0291	0.0286	-1.93	0.0291	-0.22
Single	0.0522	0.0499	-4.32	0.0515	-1.25
Sole parents	0.0185	0.0178	-3.79	0.0177	-4.13
All	0.0395	0.0381	**-3.37**	0.0391	**-0.97**
Atkinson: $\varepsilon = 0.5$					
Couple	0.0824	0.0810	-1.65	0.0819	-0.59
Couple+dependents	0.0692	0.0679	-1.88	0.0690	-0.28
Single	0.1273	0.1227	-3.59	0.1256	-1.32
Sole parents	0.0441	0.0429	-2.57	0.0423	-4.06
All	0.0951	0.0922	**-3.07**	0.0941	**-1.06**
Atkinson: $\varepsilon = 0.8$					
Couple	0.1302	0.1283	-1.44	0.1293	-0.71
Couple+dependents	0.1068	0.1049	-1.78	0.1064	-0.35
Single	0.2042	0.1987	-2.71	0.2015	-1.31
Sole parents	0.0673	0.0664	-1.37	0.0646	-3.97
All	0.1485	0.1445	**-2.70**	0.1469	**-1.12**
Atkinson: $\varepsilon = 1.4$					
Couple	0.2226	0.2204	-0.97	0.2205	-0.95
Couple+dependents	0.1884	0.1858	-1.38	0.1876	-0.45
Single	0.4342	0.4323	-0.45	0.4311	-0.73
Sole parents	0.1077	0.1087	0.87	0.1037	-3.75
All	0.2763	0.2721	**-1.50**	0.2735	**-0.98**
Atkinson: $\varepsilon = 2.0$					
Couple	0.3110	0.3094	-0.50	0.3074	-1.14
Couple+dependents	0.3563	0.3550	-0.37	0.3552	-0.31
Single	0.8711	0.8741	0.34	0.8711	0.00
Sole parents	0.1418	0.1458	2.84	0.1369	-3.48
All	0.6506	0.6527	**0.31**	0.6498	**-0.13**

Table 11: Comparing Poverty Impacts: Minimum Wages Change versus Benefit Changes: 50 per cent of Median income

	Absolute			Relative	
	Before	After	% diff.	After	% diff.
Minimum wage change					
Poverty line	$202.66	$202.66		$208.53	
$\alpha = 0$ (Headcount)					
Couple	0.0489	0.0482	-1.43	0.0492	0.61
Couple + dependents	0.0735	0.0673	-8.44	0.0701	-4.63
Single	0.1783	0.1701	-4.60	0.1766	-0.95
Sole parents	0.1508	0.1274	-15.52	0.1559	3.38
All	0.1002	0.0931	**-7.09**	0.0993	**-0.90**
$\alpha = 1$ (Poverty gap)					
Couple	0.0386	0.0385	-0.26	0.0388	0.52
Couple + dependents	0.0588	0.0585	-0.51	0.0588	0.00
Single	0.1018	0.1006	-1.18	0.1027	0.88
Sole parents	0.0162	0.0140	-13.58	0.0176	8.64
All	0.0580	0.0573	**-1.21**	0.0584	**0.69**
$\alpha = 2$ (Incl. within-poor inequality)					
Couple	0.1875	0.1875	0.00	0.1793	-4.37
Couple + dependents	0.7469	0.7469	0.00	0.7086	-5.13
Single	0.1886	0.1883	-0.16	0.1835	-2.70
Sole parents	0.0033	0.0029	-12.12	0.0037	12.12
All	0.3647	0.3646	**-0.03**	0.3476	**-4.69**
Benefit changes					
Povery line	$202.66	$202.66		$202.03	
$\alpha = 0$ (Headcount)					
Couple	0.0489	0.0445	-9.00	0.0438	-10.43
Couple + dependents	0.0735	0.0662	-9.93	0.0653	-11.16
Single	0.1783	0.1555	-12.79	0.1555	-12.79
Sole parents	0.1508	0.1052	-30.24	0.1052	-30.24
All	0.1002	0.0856	**-14.75**	0.0850	**-15.17**
$\alpha = 1$ (Poverty gap)					
Couple	0.0386	0.0376	-2.59	0.0376	-2.59
Couple + dependents	0.0588	0.0581	-1.19	0.0581	-1.19
Single	0.1018	0.1003	-1.47	0.1001	-1.67
Sole parents	0.0162	0.0138	-14.81	0.0136	-16.05
All	0.0580	0.0568	**-2.07**	0.0567	**-2.24**
$\alpha = 2$ (Incl. within-poor inequality)					
Couple	0.1875	0.1873	-0.11	0.1882	0.37
Couple + dependents	0.7469	0.7466	-0.04	0.7509	0.54
Single	0.1886	0.1883	-0.16	0.1889	0.16
Sole parents	0.0033	0.0029	-12.12	0.0028	-15.15
All	0.3647	0.3644	**-0.08**	0.3664	**0.47**

8 Allowing for Spillover Effects

This section returns to the minimum wage change simulations discussed in Section 6, but makes some allowance for the possibility of wage spillover effects further up the wage distribution above the new minimum wage. The question of interest here is how far allowing for such spillovers undermines or reinforces the previous evidence of limited reductions in inequality or poverty associated with minimumm wage increases. As mentioned in Section 2, the empirical evidence for spillovers from the introduction of, or increases in, a minimum wage remains ambiguous, with Autor *et al.* (2016) finding some limited impact across US States, while Stewart (2012) finds little support for spillovers in the UK.

The Autor *et al.* evidence for spillovers was based on an extensive analysis of the inequality impacts of minimum wages in the US, examining changes in the inequality of incomes at the p^{th} percentile relative to the median, using the logarithm of the wage at the p^{th} percentile ($p \geq 10$) minus the logarithm of the wage at the 50^{th} percentile as their inequality measure. They found some modest impacts on wage inequality at percentiles of the wage distribution from the 10^{th} percentile (the minimum wage applies below this level) to around the 20^{th} to 30^{th} percentiles, with conclusions depending on interpretations of confidence intervals around estimated parameters.

Based on this evidence, to investigate the effects on simulation outcomes of spillovers, substantial wage spillovers are imposed in which all wage rates above the new minimum, up to the median wage (of \$20.87) are increased, with the spillover effect diminishing in size as the wage rate approaches the median. That is, gross wage rates just above the minimum of \$16.50 are raised by the same amount as the minimum wage increase, namely \$3, with this amount declining linearly to zero at the median wage.

The resulting impact on the wage distribution can be seen in the histogram in Figure 4, which focuses on the relevant segment of the distribution between \$16.50 and \$25.00, using wage class widths of \$0.25. The figure shows the substantial jump in the numbers of wage earners in classes with lower bounds from \$19.50 to \$20.75, where those previously with wages in the range \$16.51 to \$19.50 are given a wage increment up to \$3. Above the median wage of \$20.87 there is no change in the distribution, by design.

To identify the effects on inequality, Table 12 compares inequality outcomes from simulations 'with' and 'without' spillovers, using the same Atkinson inequality measures reported in Table 7, for six values of ε from 0.1 to 2.0. Indices for both net income and money metric utility are shown. In general, the effect of adding a substantive spillover effect – affecting individuals up to median income levels – is to produce only a modest or minor difference in the inequality change outcomes from the minimum wage increase.

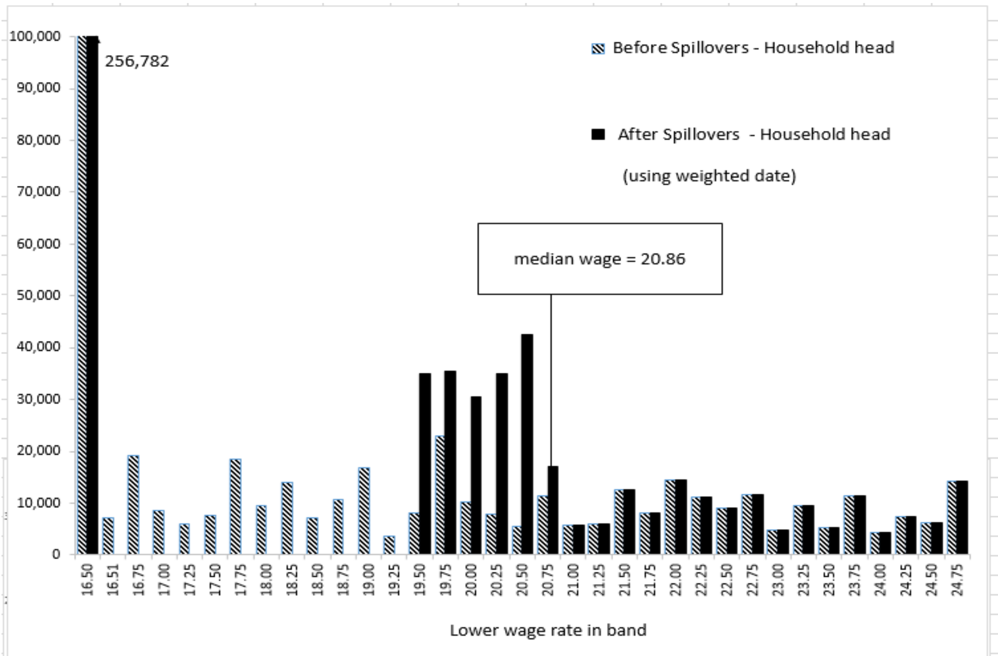

Figure 4: Wage Distribution Before and After Spillovers

For example, Table 12 indicates that, for all households combined, the previous inequality changes for $\varepsilon = 0.1$ and $\varepsilon = 0.2$, of -3.45 and -3.37 per cent respectively, become -3.71 and -3.58 per cent when allowing for spillovers. That is, inequality impacts remain relatively small, with spillovers in general having a minor impact. Similarly, at high inequality aversion, the previously reported small increase in inequality (at $\varepsilon = 2.0$) is only slightly affected: 0.31 becomes 0.52 with spillovers. Using money metric utility (which allows for the value of non-work time), previous results suggested very small inequality impacts and these are confirmed when allowing for spillovers, with Atkinson indices very similar, or identical, in both cases.[20]

Table 13 reports comparable results for the effects of increasing the minimum wage on social welfare, with and without allowing for spillovers. To save space these are only shown for all demographic groups combined.

Allowing for wage spillovers can be expected to have a larger impact on social welfare calculations than on the inequality measures since mean income appears in the abbreviated social evaluation function. Table 13 shows that this is indeed the case, with somewhat larger increases in social welfare when allowing for spillovers, at least at lower values of ε. For

[20] Making similar comparisons for the previously reported poverty measures yields identical poverty outcomes with and without assumed spillovers. This reflects the fact that both the 40 per cent, and 50 per cent, of median poverty lines are below the levels of wages affected by the spillover assumption.

Table 12: Percentage Change in Atkinson Inequality Measures: With and Without Spillovers

	Net Income		Money Metric Utility	
Spillovers:	Without	With	Without	With
$\varepsilon = 0.1$				
Couple	-1.89	-2.31	-0.28	-0.25
Couple+dependents	-1.95	-2.38	-0.58	-0.82
Single	-4.54	-4.92	-0.73	-0.73
Sole parents	-4.19	-4.09	-0.45	-0.44
All	-3.45	-3.71	-0.52	-0.55
$\varepsilon = 0.2$				
Couple	-1.84	-2.22	-0.24	-0.18
Couple+dependents	-1.93	-2.34	-0.56	-0.78
Single	-4.32	-4.62	-0.62	-0.58
Sole parents	-3.79	-3.65	-0.39	-0.37
All	-3.37	-3.58	-0.47	-0.47
$\varepsilon = 0.5$				
Couple	-1.65	-1.91	-0.10	0.02
Couple+dependents	-1.88	-2.18	-0.50	-0.65
Single	-3.59	-3.66	-0.31	-0.16
Sole parents	-2.57	-2.35	-0.20	-0.15
All	-3.07	-3.15	-0.31	-0.23
$\varepsilon = 0.8$				
Couple	-1.44	-1.59	-0.03	0.21
Couple+dependents	-1.78	-1.98	-0.42	-0.51
Single	-2.71	-2.59	-0.02	0.21
Sole parents	-1.37	-1.08	-0.02	0.06
All	-2.70	-2.66	-0.16	-0.02
$\varepsilon = 1.4$				
Couple	-0.97	-0.91	0.22	0.47
Couple+dependents	-1.38	-1.38	-0.21	-0.17
Single	-0.45	-0.11	0.31	0.54
Sole parents	0.87	1.31	0.30	0.43
All	-1.50	-1.28	0.11	0.31
$\varepsilon = 2.0$				
Couple	-0.50	-0.27	0.31	0.57
Couple+dependents	-0.37	-0.15	0.05	0.16
Single	0.34	0.45	0.09	0.14
Sole parents	2.84	3.39	0.55	0.71
All	0.31	0.52	0.13	0.22

Table 13: Percentage Welfare Changes: With and Without Spillovers

Spillovers:	Without	With	Without	With
	Net Income		Money Metric Utility	
$\varepsilon = 0.1$	1.87	2.49	0.60	0.93
$\varepsilon = 0.2$	1.93	2.56	0.61	0.94
$\varepsilon = 0.5$	2.12	2.75	0.62	0.95
$\varepsilon = 0.8$	2.27	2.88	0.62	0.92
$\varepsilon = 1.4$	2.38	2.91	0.52	0.74
$\varepsilon = 2.0$	1.20	1.42	0.16	0.22

example, based on net incomes and with $\varepsilon = 0.1$, social welfare increases by 2.49 per cent compared with 1.87 per cent with no spillovers.

However at very high inequality aversion, $\varepsilon = 2.0$, the difference is more modest: 1.42 versus 1.20. Unsurprisingly, when money metric utility is used, the results 'with spillovers' remain very small but can be around one-third larger than when spillovers are excluded; for example, percentage increases in social welfare of 0.93 versus 0.60 when $\varepsilon = 0.1$.

The results in this section therefore suggest that, even when allowing for wage spillovers a long way up the wage distribution, the effects of a substantial increase in the minimum wage on inequality and social welfare are generally quite small. Hence the *ceteris paribus* labour supply effects from a minimum wage increase would appear to be only slightly modified if wage spillovers are thought likely to be important.

9 Conclusions

This paper has sought to examine the potential effects of a minimum wage change on inequality and poverty, based on a microsimulation model which allows for labour supply responses. It then compared these outcomes to an alternative commonly used policy of raising government welfare benefits, similarly aimed at poverty or inequality reduction.

Debates on the economic impacts of increases in minimum wages often focus on efficiency consequences, for example in the form of spillover wage increases further up the income scale or changes in unemployment or consumer prices. However, the evidence for each of these is typically mixed, at best. The present modelling approach therefore abstracted from such demand-side consequences in order to estimate the *ceteris paribus* impact on the redistributional objectives of the two policies, allowing for supply-side responses in the form of labour supply changes.

The model examined the specific case of changes in minimum wages in New Zealand (from the current level of \$13.50 to \$16.50) using a microsimulation model that captures the complexities of the New Zealand income tax and transfer system. It also allowed examination of labour supply and distributional effects decomposed by four household types, based on data from the Household Economic Survey.

Results for the minimum wage policy suggested that, due to the composition of household incomes a policy of increasing the minimum wage appears to have a relatively small effect on the inequality of income per adult equivalent person, based on several inequality measures. Indeed, it was shown that for high aversion to inequality, a minimum wage increase can actually increase overall inequality. Thus the minimum wage policy was not particularly well targeted at its objective. This largely reflected the fact that many low-wage earners are secondary earners in higher-income households, while many other such households have no wage earners at all. Notwithstanding the small estimated reductions in inequality, results in the Appendix suggested that ignoring endogenous labour supply changes can lead to substantial under-estimates of the changes in inequality associated with the minimum wage reform.

Identifying the inequality or poverty outcomes of a suitable alternative redistributional policy that involves increasing welfare benefits that could be regarded as, in some sense, equivalent is not straightforward. In this case there is no simple fiscal equivalence since the minimum wage increase typically involves a regulatory change imposed on employers, while benefit increases are a more conventional fiscal tool to which revenue-neutrality can be applied. However, it was suggested that one way to compare alternatives is to consider a minimum wage increase hypothetically funded by the government, after accounting for positive revenue feedbacks through higher income tax revenues and lower benefit payments. This could then be compared with a net revenue-equivalent increase in basic benefit levels: no attempt was made to improve the 'target efficiency' of the tax-benefit structure by modifying benefit abatement rates.

Given the evidence of inefficient targeting (for redistributional objectives) of the minimum wage policy identified above, it might be expected that a fiscally equivalent benefit increase (of \$12.50) would be better targeted and thus have greater inequality and poverty reducing impacts. However, modelling suggests that while this seems to be the case for most poverty measures examined, it was found not to be the case for inequality measures. Indeed, the evidence suggests much smaller inequality reductions associated with benefit level increases, compared with the minimum wage increase, even though the latter were also found to be small.

Decomposing results by household type, the only exception to this conclusion related to sole parent households for whom poverty and inequality reductions were almost always greater, and often quite substantial, with a benefit increase compared with a minimum wage increase. This almost certainly arises because a large fraction of sole parents in the sample (and population) are benefit recipients who either do not work or work few hours. By contrast, where couple households include non-working members or those working part-time, and who do not qualify for benefits, such that benefit changes are largely irrelevant. Similarly, single person households, unless unemployed, would not typically be eligible for significant levels of welfare benefits.

These results highlight the limited redistributional gains that are achievable, at least in New Zealand, by either a minimum wage or social welfare benefit increase. Perhaps a more effective policy option to target low income households better would be via means-tested family-based fiscal transfers such as family tax credits (including in-work tax credits), or some combination of a minimum wage change and a fiscal policy change. Such policies – subject to the well-known 'tensions' in policy design – give rise to many choices and have not been examined here, but suggest potential avenues for future research.

Appendix: Inequality Effects with Fixed Labour Supply

This Appendix examines the impact of the simulated minimum wage increase on inequality, prior to any labour supply adjustments. The already small redistributive effects of a minimum wage raise are further reduced when labour supply is considered to be fixed. In the case of sole parents, inequality is seen to increase for all degrees of inequality aversion. The comparisons show that allowing for potential labour supply effects of an increase in the minimum wage matters substantively in the calculation of inequality measures.

Table 14: Atkinson Inequality Measures for Demographic Groups (Fixed Labour Supply): Net Income and Money Metric Utility Per Adult Equivalent Person

	Net income			Money metric utility		
	Before	After	% Change	Before	After	% Change
$\varepsilon = 0.1$						
Couple	0.0168	0.0165	-1.33	0.0228	0.0227	-0.28
Couple+dependents	0.0149	0.0146	-1.62	0.0248	0.0247	-0.57
Single	0.0264	0.0260	-1.55	0.0290	0.0288	-0.66
Sole parents	0.0094	0.0090	0.21	0.0117	0.0116	-0.14
All	0.0200	0.0198	-1.04	0.0255	0.0254	-0.40
$\varepsilon = 0.2$						
Couple	0.0334	0.0329	-1.27	0.0458	0.0457	-0.23
Couple+dependents	0.0291	0.0287	-1.61	0.0477	0.0474	-0.55
Single	0.0522	0.0515	-1.39	0.0581	0.0577	-0.56
Sole parents	0.0185	0.0185	0.25	0.0228	0.0228	-0.12
All	0.0395	0.0391	-0.97	0.0502	0.0500	-0.36
$\varepsilon = 0.5$						
Couple	0.0824	0.0814	-1.10	0.1156	0.1155	-0.10
Couple+dependents	0.0692	0.0681	-1.57	0.1083	0.1077	-0.49
Single	0.1273	0.1261	-0.92	0.1473	0.1469	-0.27
Sole parents	0.0441	0.0442	0.35	0.0539	0.0539	-0.05
All	0.0951	0.0943	-0.77	0.1212	0.1210	-0.21
$\varepsilon = 0.8$						
Couple	0.1302	0.1290	-0.92	0.1860	0.1860	0.03
Couple+dependents	0.1068	0.1052	-1.49	0.1629	0.1623	-0.42
Single	0.2042	0.2033	-0.45	0.2435	0.2434	-0.01
Sole parents	0.0673	0.0676	0.44	0.0825	0.0825	0.01
All	0.1485	0.1477	-0.56	0.1907	0.1905	-0.07
$\varepsilon = 1.4$						
Couple	0.2226	0.2214	-0.53	0.3234	0.3241	0.22
Couple+dependents	0.1884	0.1863	-1.16	0.2826	0.2820	-0.21
Single	0.4342	0.4357	0.33	0.5197	0.5212	0.29
Sole parents	0.1077	0.1084	0.59	0.1349	0.1350	0.12
All	0.2763	0.2760	-0.11	0.3573	0.3578	0.15
$\varepsilon = 2.0$						
Couple	0.3110	0.3105	-0.16	0.4466	0.4479	0.31
Couple+dependents	0.3563	0.3552	-0.32	0.5165	0.5168	0.05
Single	0.8711	0.8729	0.20	0.9159	0.9166	0.08
Sole parents	0.1418	0.1428	0.70	0.1844	0.1848	0.21
All	0.6506	0.6523	0.25	0.7577	0.7586	0.12

References

[1] Atkinson, A.B. (2015) *Inequality: What Can Be Done?* Cambridge, MA: Harvard University Press.

[2] Atkinson, A.B., Leventi, C., Nolan, B., Sutherland, H. and Tasseva, I. (2017) Reducing poverty and inequality through tax-benefit reform and the minimum wage: the UK as a case-study. *The Journal of Economic Inequality*, 15(4), 303-323.

[3] Autor, D. H., Manning, A. and Smith, C.L. (2016) The contribution of the minimum wage to US wage inequality over three decades: a reassessment. *American Economic Journal: Applied Economics*, 8, 58-99.

[4] Blundell, R., Brewer, M. and Francesconi, M. (2008) Job changes, hours changes and the path of labour supply adjustment. *Journal of Labor Economics*, 26, 421–453.

[5] Blundell, R. and Shephard, A. (2012) Employment, hours of work and the optimal taxation of low income families. *Review of Economic Studies*, 79, 481-510.

[6] Brewer, M. and De Agostini, P. (2015) The National Minimum Wage and its interaction with the tax and benefits system: a focus on Universal Credit. *Euromod Working Paper,* EM 2/15.

[7] Brown, C., Gilroy, C. and Kohen, A. (1982) The effect of the minimum wage on employment and unemployment. *Journal of Economic literature*, 20, 487-528.

[8] Burkhauser, R.V. and Finegan, T.A. (1989) The minimum wage and the poor: the end of a relationship. *Journal of Policy Analysis and Management*, 8, 53-71.

[9] Burkhauser, R.V. and Sabia, J.J. (2007) The effectiveness of minimum-wage increases in reducing poverty: past, present, and future. *Contemporary Economic Policy*, 25, 262-281.

[10] Capéau, B., Decoster, A. and Dekkers, G. (2016) Estimating and simulating with a random utility random opportunity model of job choice. Presentation and application to Belgium. *International Journal of Microsimulation*, 9, 144-191.

[11] Chapple, S. (1997) Do minimum wages have an adverse impact on employment? Evidence from New Zealand. *Labour Market Bulletin*, 2, 25-50.

[12] Creedy, J. (2017) Alternative distributions for inequality comparisons. *Australian Economic Review*, 50, 484-497.

[13] Creedy, J. and Kalb, G. (2006) *Labour Supply and Microsimulation*. Cheltenham: Edward Elgar.

[14] Creedy, J., Hérault, N. and Kalb, G. (2011) Measuring welfare changes in behavioural microsimulation modelling: accounting for the random utility component. *Journal of Applied Economics*, 14, 5-34.

[15] Creedy, J., Kalb, G. and Scutella, R. (2004) Evaluating the income distribution effects of tax reforms in discrete hours models. In *Research in Economic Inequality, Volume 12* (ed. by Y. Amiel and J. Bishop), pp. 199-226. New York: JAI Press.

[16] Creedy, J., Kalb, G. and Scutella, R. (2006) Income distribution in discrete hours behavioural microsimulation models: an illustration. *Journal of Economic Inequality*, 4, 57-76.

[17] Creedy, J., Gemmell,N., Enright, J. McNabb, N. (2010) Income redistribution and direct taxes and transfers in New Zealand *Australian Economic Review*, 43, 39-51.

[18] Dickens, R. and Manning, A. (2004) Spikes and spill-overs: the impact of the national minimum wage on the wage distribution in a low-wage sector. *The Economic Journal*, 114, C95-C101.

[19] Duncan, G.J. and Hill, D.H. (1985) An investigation of the extent and consequences of measurement error in labor-economic survey data. *Journal of Labor Economics*, 3, 508-532.

[20] Foster, J., Greer, J., and Thorbecke, E. (1984) A class of decomposable poverty measures. *Econometrica*, 52, 761-766.

[21] Goraus-Tanska, K. and Lewandowski, P. (2018) Minimum wage violation in Central and Eastern Europe. *International Labour Review*, doi.org/10.1111/ilr.12086.

[22] Gosling, A. (1996) Minimum wages: possible effects on the distribution of income. *Fiscal Studies*, 17, 31-48.

[23] Hyslop, D. and Stillman, S. (2007). Youth minimum wage reform and the labour market in New Zealand. *Labour Economics*, 14, 201-230.

[24] King, P. and Waldegrave, C. (2012) Report of an investigation into defining a living wage for New Zealand. *Living Wage Aotearoa New Zealand.*

[25] Maloney, T. (1995) Does the adult minimum wage affect employment and unemployment in New Zealand? *New Zealand Economic Papers*, 29, 1-19.

[26] Manning, A. (2003) *Monopsony in Motion: Imperfect Competition in Labor Markets.* Princeton University Press.

[27] Mercante, J. and Mok, P. (2014a). Estimation of labour supply in New Zealand. *New Zealand Treasury Working Paper*, WP 14/08.

[28] Mercante, J. and Mok, P. (2014b). Estimation of wage equations for New Zealand. *New Zealand Treasury Working Paper*, WP 14/09.

[29] Ministry of Business, Innovation and Employment (2013) *Regulatory Impact Statement for Minimum Wage Review 2012.* Retrieved from https://www.mbie.govt.nz/publications-research/publications/employment-and-skills/RIS%20Minimum%20Wage%20Review%202012%20PDF%20714kB.pdf/view.

[30] Müller, K.U. and Steiner, V. (2009) Would a legal minimum wage reduce poverty? A microsimulation study for Germany. *Journal of Income Distribution*, 18, 131-151.

[31] Müller, K-U. and Steiner, V. (2013) Behavioural effects of a federal minimum wage and income inequality in Germany. In Jahrestagung des Vereins für Socialpolitik 2013: Wettbewerbspolitik und Regulierung in einer globalen Wirtschaftsordnung. Retrieved from http://hdl.handle.net/10419/79784.

[32] Neumark, D. and Wascher, W.L. (2007) Minimum wages and employment. *Foundations and Trends in Microeconomics*, 3, 1-182.

[33] Neumark, D. and Wascher, W.L. (2008) *Minimum Wages*, Cambridge, MA: MIT Press.

[34] OECD (2015) *Focus on Minimum Wage after the Crisis: Making Them Pay.* Directorate of Employment, Labour and Social Affairs. Paris: OECD.

[35] Pacheco, G.A. and Maloney, T. (1999) Does the minimum wage reduce the employment prospects of unqualified New Zealand women? *Labour Market Bulletin*, 1, 51-69.

[36] Pacheco, G.A. and Cruickshank, A.A. (2007) Minimum wage effects on educational enrollments in New Zealand. *Economics of Education Review*, 26, 574-587.

[37] Rani, U., Belser, P., Oelz, M. and Ranjbar, S. (2013) Minimum wage coverage and compliance in developing countries. *International Labour Review*, 152, 381-410.

[38] Rodgers, W.L., Brown, C. and Duncan, G.J. (1993) Errors in survey reports of earnings, hours worked, and hourly wages. *Journal of the American Statistical Association*, 88, 1208-1218.

[39] Skinner, C., Stuttard, N., Beissel-Durrant, G. and Jenkins, J. (2002) The measurement of low pay in the UK labour force survey. *Oxford Bulletin of Economics and Statistics*, 64, 653-676.

[40] Stewart, M.B. (2012) Wage inequality, minimum wage effects, and spillovers. *Oxford Economic Papers*, 64, 616-634.