The Incidence of an Earned Income Tax Credit: Evaluating the Impact on Wages in the UK

JOB MARKET PAPER

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Abstract

This paper proposes a simple general equilibrium model to investigate the impact of an earned income tax credit on the equilibrium gross wage. Under the assumption that the employer has knowledge, or at least awareness, of which of her employees are claiming, she may share in the incidence of the tax credit by cutting the gross wage. Moreover, given the level of substitutability between the claimant employees and other employees, the model predict that as the fraction of claimants and the average rate of subsidy increases in the work-place, the wage fall for workers in the same skill groups (i.e. the "spillover") also increases. The empirical investigation examines the introduction of the Working Families’ Tax Credit in the UK in 1999, using parametric and non parametric two stage censored regression method and data on women. We find evidence to suggest that although there is no discrimination in the relative wage fall of WFTC claimants to similarly skilled non-claimants (non eligible), except for when we look at lone mothers, there is a strong spillover effect.

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1 Introduction

Over the last two decades there has been a huge expansion across many OECD countries in welfare to work programmes. Different approaches have been carried out to enhance the labour market attachment and earnings amongst the low skilled. The three, often conflicting, goals are to raise the standard of living; encourage work and self sufficiency and to keep government costs low.

A popular policy has been to use earned income tax credit. For example, Earned Income Tax Credit in the USA, Self-Sufficiency Program in Canada and the Working Families’ Tax Credit (WFTC) in the UK. In general, these "tax subsidy" policies are motivated by the desire to encourage participation and hours of work of certain groups in the economy (for example, lone parents and low income couples). These so-called "in-work benefit" aim to alleviate poverty at the lower end of the wage distribution, reducing income inequality and redistribute income by reducing the dispersion of earnings.

Given the prior aims and motivations of such policies, most of the literature to date focuses on estimating the change in labour supply response to changes/introductions of tax credit policies. The complexity of the distortion in the household’s budget constraints gives rise in the literature to look at the changes in the hours worked, participation, impact of child-care components and the effect on the secondary earner in the household. In particular, with regards to the WFTC, once the income and substitution effect are accounted for, most of the analysis concludes a successful changeover from Family Credit. The policy had a "more than average" impact on lone parent and women with unemployed partners. More recently some work has been done to investigate the impact of increased labour supply resulting from these earned income tax credit policies on the equilibrium wage.

The question that this paper aims to investigate is whether there is evidence to suggest that tax credits

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1 The minimum working hours based credit for families with children that preceeded the WFTC.
are not fully incident on the employee who is eligible\(^3\) and claiming the tax credit. This can be with or without a boost to the economy’s overall labour supply. We use a simple general equilibrium model to show that under the assumption that the employer has formal knowledge, or at least awareness, of which of his employees are claiming a tax credit, she may share in the incidence of the tax credit by cutting the gross equilibrium wage of the claimant worker. This can be done without reducing the worker’s net equilibrium wage, such that the worker is no worse off and, more likely, still better off from receiving the tax credit. Moreover, given the degree of substitution between the claimant and other workers, the model predicts that there may be a spillover effect which reduces the wage of both eligible and similarly skilled ineligible workers. The information assumption is still important here since by knowing the fraction of eligible workers and the average amount claimed in the work-place, the employer may be able to extract more (or less) of the tax credit through the "spillover”.

The effect in question may indirectly depend on a number of other factors which are more specific to the country where the introduction/change in policy occurs or the type of labour market. Firstly, the method in which the tax credit is paid may play a vital role since it can alter the amount of information that the employer has about her employees’ eligibility circumstances. For example, the Working Families’ Tax Credit in the UK differed from Family Credit, its predecessor, in that it was paid via the wage packet. The motivation for this change was to reduce the stigma attached to receiving tax credits (in the form of a welfare benefit) but by using this method, it gave employers complete information on which employees were claiming and also how much WFTC they were receiving. Secondly, institutional factors such as minimum wages may impose a lower bound below which the employer can not cut the wage. This was the case in the UK with the introduction of the National Minimum Wage (NMW) in April 1999. This is also important because it implies that those at the lower end of the wage distribution are more likely to be protected by the national

\(^3\)Eligibility usually being contingent on having children, working a certain number of hours and having a household income below a certain threshold level.
minimum from a cut in gross wage. Additionally and perhaps more obviously, those at the top end of the wage distribution are unlikely to be affected because tax credits are less relevant to their household income (as they probably receive too little or they earn too much to be eligible). It is, therefore, those in the middle of the wage distribution who are most severely affected. Finally, the behavioural response of the worker to a change in the gross wage relative to the net wage is very important in this case. In Anglo-Saxon countries it is the case that when a worker is asked their wage rate, they tend to quote their gross wage where as in Mediterranean countries, such as Italy, the worker will quote her net wage.

The empirical investigation is carried out using the change in the UK in October 1999 when the government replaced the Family Credit, a minimum working hours based credit for families with children, with the Working Families’ Tax Credit. The change in policy altered the eligibility criteria and it became more generous \(^4\). The analysis uses data on only women as they are the largest group of tax payers eligible for WFTC and they are the group most relevant for studying whether WFTC reduces welfare dependency. Although focusing on this policy change is interesting in its own right, it is made even more fascinating by the fact that it incorporates some of the factors mentioned above. Namely that the National Minimum Wage (NMW) was introduced six months prior to the WFTC and that WFTC was paid via the wage packet. The introduction of the NMW may be argued to be a nuisance in the analysis since it affects similar "types" of people as WFTC but it still offers an interesting identification strategy as it acts as an exogenous barrier below which the employer can not cut the gross wage. Without spending too much time here on the mechanics of how the WFTC is paid\(^5\), it is important to clarify the institutional role which allows us to analyse this policy. In the UK employers became responsible in April 2000 for paying the WFTC through the employees’ wage or salary. The eligible claimant would claim the approximate tax credit from the Inland Revenue who would then work out the amount of tax credit payable. The Inland Revenue would then notify the relevant

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\(^4\) A more in-depth description will be given in a later section

\(^5\) See Section 4.
employer of the amount of tax credit to be paid and when the tax credit is to start and finish\textsuperscript{6}. Employers would pay the tax credit out of the tax and National Insurance contribution that they would otherwise have forwarded to the Inland Revenue\textsuperscript{7}.

In the USA there is a growing amount of literature on the impact of the Earned Income Tax Credit on wage growth (Rothstein, 2005 and Leigh, 2004), however differences in the institutional structure of the Working Families’ Tax Credit in the UK make it an interesting policy to investigate. In particular, the EITC is paid mainly in a single annual lump sum, rather than monthly and there is no attempt to integrate it to a larger income security system. In the UK, on the other hand, payment of WFTC through the wage packet made the employer responsible for the payment of the tax credit and so increased the connection between the wage-setting firm and the claimant employee. This paper tries to exploits these differences to try to get a good measure of the effect of tax credits on wages.

Using both a parametric and non-parametric two-stage censored regression based technique, this paper finds evidence to suggest that for lone parents there is evidence to support that a firm discriminates by cutting the wage of the claimant worker relative to a similarly skilled non-claimant. The most compelling result of this paper is the strong "spillover" effect. We find that as the average amount of WFTC and the fraction of employees claiming WFTC increases, the wages of both claimants and non-claimants who have the same predicted wage (before WFTC) falls. We use two measures for WFTC: (1) the reported number of claimants and (2) the amount of WFTC which is calculated using the eligibility criteria. The analysis is extended to show that the size of the firm plays a vital role in the size of the incidence transfer. Finally we address the concerns in our analysis surrounding selectivity in the "take-up" rates and the problem of previously ineligible workers altering their behaviour to become eligible. The overall conclusion remains

\textsuperscript{6}It is important to note that this notification would not break down the various components of the credit or distinguish between the WFTC and disabled person’s tax.

\textsuperscript{7}This means that the employer will lose the benefit of the time lag between marking these deductions and forwarding on the account office.
unchanged.

These results have important academic and policy implications. In particular, they imply that there is a significant shift in the burden of tax credits, in line with the theory presented. This is of critical policy importance as we can no longer assume that it is the case that the person eligible for such tax credits is the sole beneficiary. These results are critical to our understanding of the consequences of the expansion, application and generosity of tax credits. Moreover, the way in which they are distributed may have unexpected consequences.

The rest of the paper is structured as follows: Section 2 gives a brief overview of the past literature on tax credits, Section 3 introduces a general equilibrium model which tries to explain how a tax credit can reduce the gross equilibrium wage. In Section 4 a short history and the main descriptive statistics are given for tax credit policy changes in the UK. Section 5 describes the empirical framework used to test the hypothesis proposed in Section 3. Section 6 describes the data and explains the main results. Section 7 extends the analysis from Section 6 and highlights and deals with potential problems. Section 8 discusses the implications of these results and suggests policy implications. Finally, Section 9 concludes.

2 Related Literature

As mentioned in the introduction, much of the literature to date focuses on evaluating the participation effect of tax credit changes/introduction. One of the most well known paper is that of Eissa & Leibman (1996) where the authors examine the impact of the Tax Reform Act of 1986 in the USA which included the expansion of the Earned Income Tax Credit (EITC). They focus on the labour market participation and hours of work of single women with children and identify the change by comparing the change in the labour supply of single women with children and single women without children. They find that labour supply
increases by 2.8%. Another prominent paper which focuses on the changes in labour supply of single women in the USA is that of Meyer and Rosenbaum (1999). They, however, take a more general approach to looking at various policy changes in the US in the 1980s and 1990s which affect this group of women. They find that although benefit cuts, welfare time limit alterations, changes in training programs and childcare expansions had some impact on making women with children work, the largest share of the increase could be attributed to reforms in EITC. In a paper by Blundell & Hoynes (2001), they examine the labour market impact of in-work benefit reform in the UK and then compare it with the USA policy reform (i.e. EITC). They look at why the impact of similar reforms in the UK seem to be small relative to the USA (in terms of increasing employment rates). They conclude that it is attributed to the interactions with other means tested benefits in the UK, the importance of workless couples with kids, the level of income support given to non-working parents and the strength of the USA upturn in the 1990s.

There are, however, a growing number papers that go beyond looking purely at participation effects from tax subsidies. In particular an interesting aspect is that of the effect on skill formation resulting from increased participation (Card, Michalopoulos & Robins (2001), Heckman, Lochner & Cossa (2002)). The main question posed in these papers is whether tax credits create an incentive to invest in skills that are useful for the work place and/or if skills are acquired as a by-product of being in the workplace. The effects on human capital are rather ambiguous and depends on the view taken as to whether learning is rivalrous to work or not. Heckman et al find that the entry effect of EITC are small but the reduction in the average earnings amongst uneducated women can be as large as 18%. In the UK, Lydon & Walker (2004) also question whether the introduction of the Working Families’ Tax Credit (WFTC) promoted incentives to increase investment in on-the-job search and training in general skills. They look to see if factors such as these promoted wage growth and found that for people who were previously claiming Family Credit, WFTC’s predecessor, incentives are unchanged but for those who became eligible for the tax credit and had not been
previously eligible, there was a 2.7% wage progression.

More recently literature in the US has emerged which looks at the incidence of tax credits. In particular, Leigh (2004) and Rothstein (2005) use different approaches to investigate the impact of changes in the EITC in the mid-1990s to see if changes in labour supply had any impact on the equilibrium wage within the same skill group. Using variation across states in EITC supplements, Leigh (2003) generates cross-sectional variation in the average tax rate faced by women with children and finds that an increase of 10% in the generosity of EITC is associated with a 4% fall in wages of the high school drop-outs and a 2% fall in the wage of college graduates. In addition to the state variation, Leigh also uses variation across the wage distribution and still finds that increasing EITC is associated with a fall in hourly wage. The prime explanation for these results being that the increase in EITC generosity boosts labour supply as individuals respond to average falls in tax rates and not marginal tax rates. Rothstein uses variation across the wage distribution in the implications of the mid-1990s federal EITC expansion-in which maximum total credits and associated marginal total credits and associated marginal tax rates approximately doubled over a three year period-to identify the EITC’s effect on women’s aggregate labour supply and on the female wage schedule. He found that wage changes were insignificant given the rise in labour supply but the wage of EITC eligible women grew at a slower rate than that of non-eligible women.

This paper builds on the research carried out on the US by focusing on the institutional differences of Working Families’ Tax Credit, introduced in the UK in 1999, which make it a fascinating policy to study. In particular the payment of WFTC through the wage packet made the employer responsible for the payment of the tax credit and so increased the connection between the wage-setting firm and the claimant employee. This differs from the EITC which is paid mainly in a single annual lump sum to the eligible families.
3 Tax Credit Incidence: Theoretical Approach

The aim of this section is to show how, in a theoretical setting, it is possible for a tax credit to influence the equilibrium wage in a general equilibrium framework. The Proposition adapts the Harberger (1962) model of tax incidence\(^8\) to show that a change in the tax credit will lead to a shift in the burden of the tax credit from employee to employer. Moreover the model shows that when allowing for heterogeneity between workers there is an indirect effect which affects both eligible and non-eligible. The impact of this effect will depend on the elasticity of substitution between the eligible worker and ineligible worker and the fraction of eligible workers in the work place.

The main underlying assumption is that the employer has some knowledge/information about which of her workers are eligible for the tax credit. The most simple and straightforward way in which this would be the case is when the tax credit is paid via the wage packet. Here the employer can see clearly if the worker is a claimant (and how much she is receiving). However one can still maintain this assumption even in the event that the employer does not have full information. For example, if there exists some kind of "internal knowledge" of whether or not the employee is claiming tax credit (e.g. the employer may know if his employee has children) or it may be that there is statistical discrimination.

Before introducing the main proposition, let us consider a very simple economy in which workers are perfect substitutes and the law of one wage applies. We can show that it is only when we assume that the imposition of the tax credit does not alter the "price" of different types of labour that the wage is unaffected. Moreover, it implies that it is not only the claimant (or claimant’s household) who is affected by the policy but also other groups in the economy are affected. Let workers comprise of either being eligible for a tax credit (group 1), \(N_1^s\), or ineligible for a tax credit (group 2), \(N_2^s\), and \(s\) is the subsidy rate. In equilibrium, at wage \(w\), labour demand, \(N^d\), will equal labour supply:

\(^8\)See Fullerton & Metcalf (2002) for a full review on tax incidence.
\[ N^d(w(s)) = N^*_1(w(s)(1+s) + N^*_2(w(s)) \]

The effect of the subsidy on the gross wage is characterised by:

\[ \partial \ln w / \partial \ln (1+s) = - \frac{\theta_1^*}{(\theta_1^* + (1-\theta)\theta_2 - \theta^*)} \]

See Appendix for the proof.

This simple calculation shows that, given that the expression lies between 0 and 1, we can interpret it as the fraction of the subsidy that shifts from worker to employer. The larger the supply elasticity of group 1, the more elastic the labour demand and/or the larger the fraction then the bigger the shift. Only in special circumstances will the tax credit have no effect on the gross wage\(^9\).

The path breaking general equilibrium analysis of Harberger (1962) derives the burden of a tax on capital in one sector. Here, the procedure is adapted to show the general equilibrium effect of a tax credit on input compensation in a one sector model which uses two different types of labour \((N_1, N_2)\) to produce one good \((X)\). Here the heterogeneity of workers comes from the difference in being able to satisfy the eligibility criteria.

We do not specify a particular functional form since by assuming the production function \(X = F[N_1, N_2]\) we avoid the limitations of computational general equilibrium models. This can be any production function with constant returns to scale. However, as noted by Fullerton & Metcalf (2002), using a log-linearisation method is only valid for small changes.

**Proposition 1** A change or an introduction of a tax credit under a general equilibrium setting, given that workers are not perfect substitutes, will result in a direct change in the gross wage of the eligible claimant group and an indirect effect on both groups.

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\(^9\)For example, if labour demand elasticity is infinite or if labour supply was perfectly elastic.
Let \( s \) be the subsidy rate and \( w_1 \) and \( w_2 \) be the gross wages for workers claiming the tax credit and for those not eligible (and/or not claiming), respectively. The effect of the subsidy on the gross wage is given by:

\[
\frac{\partial \ln w_1}{\partial \ln (1+s)} = -\frac{(1-\theta)\eta_1^s}{(1-\theta)\eta_1^s + \theta\eta_2^s + \sigma x} \text{ if eligible claimant (group 1)}
\]

\[
\frac{\partial \ln w_2}{\partial \ln (1+s)} = \frac{\theta\eta_1^s}{(1-\theta)\eta_1^s + \theta\eta_2^s + \sigma x} \text{ if ineligible (group 2)}
\]

The proof is given in the Appendix.

This proposition suggests that when one accounts for heterogeneity amongst workers, based on the eligibility criteria, it causes the wage of claimant workers to be different from the ineligible workers and the subsidy affects the gross wage of both groups of workers. The importance of this impact is will depend on (1) The fraction of each group, \( \theta \) and (2) the level of substitutability between the two groups, \( \sigma_x \). The substitution effect is captured in the labour demand elasticity and the effect on the non-eligible group becomes smaller as the proportion of claimants falls.

Since \( \theta \) is defined as the cost share, it is endogenous in terms of the population share. It is interesting to look at the cross-derivatives with respect to \( s \) and \( \theta \). This tells us what happens to wages when the share changes:

\[
\frac{\partial^2 \ln w_1}{\partial \ln (1+s) \partial \theta} = \frac{\eta_1^s}{(\eta_1^s + \theta\eta_2^s + \sigma x)} = \frac{\partial^2 \ln w_2}{\partial \ln (1+s) \partial \theta}
\]

We may be interested to know how the results change when we consider a non-competitive framework, for example a monopsony or a wage posting model. In his paper, Harberger (1962) addresses this issue when looking at the corporate sector. He adjusts his analysis to accommodate for potential monopoly power and concludes that the tax bites into monopoly profit as well as into the returns in capital (in the context of our model, this would be the wage). Overall, although it would be interesting to lay out a model and to see how in equilibrium the distributions of the two different types of labour and the relative prices of the labour will change, in the end the tax burden that is not directly borne by monopsony profits will be "determined by a
mechanism that differs only in minute details from that which determines the incidence of the [corporation income tax] in the competitive case\textsuperscript{10}.

4 Application: Working Families’ Tax Credit

In the UK since the 1980s there has been a dramatic shift in the composition of the lowest decile of the income distribution from pensioners to families of working age and lone parents in particular (Goodman, 2001). The Working Families’ Tax Credit (WFTC), introduced in October 1999, was designed to target low income families with an income supplement that was contingent on working. However systems of support for families with dependent children in the UK have been around since 1971 when the Family Income Support (FIS) was introduced. FIS entitled families with children and working more than 24 hours per week to an income supplement.

In 1988, FIS was renamed Family Credit (FC) with some structural reform and an increase in generosity such as the hours requirement fell to 16 hours and a childcare disregard was introduced to encourage higher participation especially amongst mothers of young children. In October 1999, FC became WFTC and the government estimated twice as many families to be in receipt of WFTC as received by FC. Figure 1 shows the number of claimants changed from 1988 to 2002\textsuperscript{11}. There were 1.1 million claims for WFTC in August 2000, which increased to 1.3 million claims in August 2001. This is almost 430,000 more than claimed under Family Credit in August 1999.

Eligibility for WFTC was based on the family income being less then £92.90, the presence of children and a minimum of 16 hours of work in the family per week. Although not innovative, it was more generous and extended further up the income distribution. In particular, the marginal deduction rate fell from 70%

\textsuperscript{10}See Harberger (1962).
\textsuperscript{11}In April 2003, WFTC changed again to the Working Tax Credit.
to 55% and there was a larger childcare subsidy. The maximum weekly rate of WFTC was made up of an adult credit, for each child and a bonus if the claimant or their partner works for 30 hours or more each week. An important aspect of the policy was that income from most other benefits, like housing benefit, child benefit and council tax benefit are not included in the calculation for the entitlement of WFTC. This, as argued in Blundell & Walker (2001), could potentially offset the work incentive effects of WFTC.

In terms of government spending on the program, by 2000 the government had spent £5 billion per year (which accounts for 1.5% of the government budget and 0.6% of the GDP). This being almost £2 billion more than what was expected under FC. The huge increase in expenditure came from increased credit per child from £19.85 to £26; the threshold support increase from £80.65 to £92.90 and, of course, the reduced taper. In addition the childcare cost accounted for 70% of actual childcare cost (accounting for weekly childcare costs up to a maximum of £135 for one child and £200 for two or more children). The effect of these changes meant that those who were currently receiving the maximum payment would see a small increase in the level of their payment if they had children under the age of 11 years old. Those with net income between £80.65 and £92.90 would move from being on the taper to receiving full support. The others on the taper would see the taper rate fall from 70% to 55% and the largest cash gain would go to those who are currently just at the end of the taper. Figure 2 shows how the average claim changed over time. In addition an encouraging sign of WFTC effectiveness was that its take-up rate by 2002 was estimated to be 72-76% compared to 66-70% under FC. The take-up rate was highest for those entitled to the biggest awards. In addition, the greater generosity of WFTC relative to FC meant that the take-up of WFTC was higher that would have been expected had FC simply continued unchanged.

As mentioned in the introduction, one key difference between FC and WFTC was that the payment was made through the wage packet. This was an attractive move because it became more convenient to distribute and it reduced the stigma attached to the tax credit for being a welfare benefit. In April 2000 the eligible
claimant would claim the approximate tax credit from the Inland Revenue who would then work out the
amount of tax credit payable. The Inland Revenue would then notify the relevant employer of the amount
of tax credit to be paid and the employer would pay the tax credit out of the tax and National Insurance
contribution that they would otherwise have forwarded to the Inland Revenue.

5 Empirical Framework

In this section we empirically test the theoretical hypothesis that a change in tax credit can lead to a shift
in the incidence from worker to employer. In addition to a direct effect on claimants, we look to see if there
exists an indirect/spillover effect of the tax credit on both claimants and similarly skilled ineligible (and/or
non claimants) which becomes stronger when the fraction of claimant workers and/or the average tax credit
amount increases within an industry. We propose both a parametric and non-parametric two stage censored
regression model to estimate these effects. Before explaining the methodology, let us begin by discussing the
identification of some key variables.

The analysis is restricted to women which follows the long tradition of empirical work done on tax
credits. Women are the largest group of taxpayers eligible for WFTC and they make up approximately 60%
of the eligible population. They are the group most relevant for studying whether WFTC reduces welfare
dependency as noted in Eissa (1995). In addition, women are the most responsive to changes in economic
activity and there is a huge variation in their income (Blundell, Duncan and Meghir, 1998).

One of the key tasks is to construct a measure for WFTC. We identify the WFTC variable in two ways:
(1) Using a simple indicator which identifies who reports claiming WFTC and (2) using the eligibility criteria
to identify those who are eligible for WFTC and the amount for which they are entitled. Since eligibility
does not imply take-up, it is good to estimate using both methods.
The receipt of WFTC differs across households for four main reasons: (1) Hourly wages, (2) hours worked, (3) household income & (4) presence of children. These four factors not only determine eligibility but will also determine the amount received. The outcome variable that is under investigation is the hourly wage variable and so the variation in the latter three factors (hours worked, household income and presence of children) can be used to evaluate the change in hourly wage which is due to the change in tax credit policy. Typically the literature on tax credits ignores the different sources of variation and the analysis is conducted by comparing people with children to those without (Eissa & Leibman, 1996; Blundell et al, 2005). We need the variation from all three factors to conduct the analysis but we are assuming that people do not alter their behaviour (significantly enough) in hours of work, for example, to make the criteria endogenous. We try to tackle the issue of potential endogeneity in the WFTC take-up in Section 7.12.

By comparing eligible with non-eligible workers who have the same pre-WFTC wage, we do not have the standard treatment and control group because of the potential spillover effects discussed in Section 3. Instead, as it will become clear later in this section, we use a cross-sectional wage structure before WFTC and then add in the wage growth and policy change to see what happens to the eligible and non-eligible with the same predicted wage. For example, suppose that two people have the same predicted wage before WFTC is introduced. They both have children and a low household income but one person (or one household) works too few hours to be eligible for WFTC. Here we compare their relative before and after wage changes.

5.1 The role of the National Minimum Wage:

In the same year as the WFTC was introduced, the UK had another important introduction: National Minimum Wage (NMW). For the first time the government introduced a national minimum in April 1999.

\(^{12}\)We are not concerned by presence of children since, at least in the short run, this will not be altered. In addition we use predicted weekly wages to work out household income (this will become clear in the next section).
of £3.60 for adults (aged 22 years and above) and £3.00 for those aged 18 - 21 years\(^{13}\). Since this policy was introduced only six months before the introduction of the WFTC, we may pose the question: Is this a nuisance or an aid for the following analysis?

We argue that the NMW plays a fundamental role in the evaluation method and is something that should not be ignored in any analysis on WFTC. It offers an unusual source of variation because it is a floor below which the employer cannot cut the wage. Although it has the strongest effect on those at the lower end of the wage distribution, as WFTC does, the NMW will protect those with the lowest wages from a wage cut (i.e. the part of the wage distribution where the employer is set to gain the most in incidence). This has a very interesting implication that it is those in the middle of the wage distribution who lose the most, since those at the upper end of the wage distribution will either not be eligible to claim or will receive so little that either they don't claim or it is not in the employer's interest to cut their wage.

5.2 The "WFTC (LFS)" Indicator:

The UK's Quarterly Labour Force Survey, which is discussed in more detail in the next section, contains information on the types of family related benefits that are claimed. From Spring 2000, information on WFTC claim is reported\(^{14}\). This is a useful variable since it helps to identify reported claimants. However, to make the analysis more rigorous and to account for the individual level of importance of WFTC (relative to household income), a "WFTC Rate" is calculated using the policy eligibility criteria.

5.3 Calculation of the "WFTC Rate" variable:

The wage change analysis becomes complicated when measuring the amount of WFTC since WFTC is computed using household income rather than individual wage. One possible way of tackling this is to use

\(^{13}\) Although there were Wage councils abolished in 1993

\(^{14}\) It is important to note that this is reported claim and not government reported actual claim.
the data to match earners in the household and then to estimate the amount of WFTC the household is entitled to claim using the eligibility criteria. This variable is then used in the regression framework. The WFTC has 3 main parts:\(^{15}\): (1) A basic credit of £59.00 (one for each family), (2) A 30 hour tax credit bonus of £11.45 (where each worker works at least 30 hours per week) and (3) A tax credit for each child in the family of £26.00. The payable WFTC is based on each component added together to make a maximum credit. If net household income \((HHInc)\) is above £92.90 per week, the maximum WFTC is reduced. There will be a reduction of £0.55 for each pound over £92.90. If the net income is below £92.90, the maximum WFTC is payable.

In general, the "WFTC" variable is calculated as follows:

\[\text{Gross WFTC} = 59.00 \text{ if hours} \geq 16 + 11.45 \text{ if hours} \geq 30 + 26.00 \text{ per child (given hours} \geq 16)\]

\[\text{Reduced WFTC} = \begin{cases} (HHInc - \£92.90 \text{ per week}) \times 55\% & \text{if } HHInc \geq \£92.90 \\ 0 & \text{otherwise} \end{cases}\]

\[WFTC = \text{Gross WFTC} - \text{Reduced WFTC}\]

It is important to note that when we calculate household weekly income we use the predicted wage (and not actual wage) of the female earner using wage data from before 1999. The weekly wages of the female earners are calculated by multiplying the predicted hourly wage with hours worked and then the total household weekly income will include the weekly wage of other members of the household. Since WFTC effects wages we can not put actual weekly earnings into calculating the WFTC variable as it would be endogenous. In addition to this, instead of using this WFTC variable in the wage analysis that follows we use the rate of WFTC \((WFTCRate)\). Since wages are used to calculate the WFTC variable they are endogenous when used as a regressor in any analysis where wage is the dependent variable. It is the case that WFTC will increase as wages (or household income) goes down. The WFTCRate, on the other hand,

\(^{15}\)Figures are given for April 2001.
is a non-linear variable which weights household \( WFTC \) by \( (predicted) \) weekly wages.

\[ \text{o } WFTC \text{ Rate } = \left( \frac{WFTC}{\text{weekly wage}} \right) \]

5.4 Two-Stage Empirical Strategy

The two components to the empirical strategy are as follows:

1. The wage is estimated before the imposition of NMW (i.e. predicted wages are calculated using data before 1999)
2. The predictions from stage 1 are used to compare the before and after effect of WFTC from 2000 to 2003.

5.4.1 Stage One: Predicted Wage

Using a linear regression method on the log wage before 1999 we estimate the expected log wage for women. This is done by controlling for individual, family and job characteristics in the vector \( X_i \). Where \( X_i \) is a 1xK vector of conditioning variables\(^\text{16}\). Although characteristics such as firm size and occupation may be endogenous, the aim of this exercise is to predict the wage as closely as possible to the earned wage without the NMW and WFTC.

The expected wage, \( \hat{w} \), is calculated such that:

\[ E(\log \text{ wage} | X) = aX = \hat{w} \]

5.4.2 Stage Two: Estimating the Wage Change

Let us consider the situation in which we have two groups of people: (1) Those eligible for (and/or claiming) WFTC and (2) those not eligible (and/or not claiming). The model predicts that the employer can gain by

\(^{16}\)The controls include: Age, Education, Region, Ethnicity, Experience (plus higher orders), Tenure (plus higher orders), Marital Status, Number of Children, Firm Size, Public Ownership, Occupation Type, Industry Type, Full-time Status.
cutting the gross wage of the eligible (claimant). In addition, the model in Section 3 predicts that as the elasticity of substitution between eligible and ineligible workers increases, the aggregate effect on the wages of all people in the same skill group will become stronger.

In the absence of the NMW we would therefore want to estimate the following equation:

\[ W_i^* = \beta_0 + \beta_1 \hat{w}_i + \beta_2 TC_i + \beta_3 (\bar{TC} \ast \theta) + u_i \]

\[ \text{st. } TC = \{WFTC}^I, WFTCrate \}

Where \( WFTC}^I \) is the LFS indicator as to whether the individual is claiming WFTC and \( WFTCrate \), as described earlier, gives the amount of WFTC divided by weekly wages. Where \( \hat{w} \) captures the predicted wage before the policy changes of 1999 are introduced. The \( TC \) should capture any overall difference between the eligible and ineligible groups (i.e. it should capture the relative growth (fall) in wage above (below) the predicted wage after the introduction of WFTC). Where \( (\bar{TC} \ast \theta) \) is a measure of the "Spillover" effect. This is estimated by taking the average WFTC, \( \bar{TC} \), in each industry and then weighting it by the fraction of WFTC eligible workers, \( \theta \), in that industry\(^{17}\).

However the imposition of the NMW in April 1999 distorts the actual wage from the predicted wage for those who the NMW binds. Figure 3 represents this distortion. It highlights that for those with a binding NMW, there exists a "Gap" between actual and predicted wage. For those who are unaffected by the NMW (i.e. those who were previously earning above the national minimum), no "Gap" exists between the actual wage and the predicted wages. This imposition implies that we have a censored regression model where the censoring point in 1999 is £3.60, the NMW\(^{18}\). At this point we have a positive probability mass at the NMW. Essentially:

\(^{17}\)When using the \( WFTC}^I \) indicator we use just the fraction of claimants in each industry as we do not have a measure of the average amount claimed in each industry.

\(^{18}\)The NMW changes between 1999 and 2003 and we adjust the censoring point accordingly.
\[ W_i = \begin{cases} w_{\text{min}} & \text{if } W_i^* \leq w_{\text{min}} \\ W_i^* & \text{if } W_i^* > w_{\text{min}} \end{cases} \]

In essence if \( W_i^* \) denotes the actual (log) wage where \( E(\log \text{wage}|X)_i = \tilde{\alpha}X_i = \tilde{w} \), we only observe \( W_i^* \) when \( W_i^* > w_{\text{min}} \) and so we can define observed (log) wages, \( W_i \), as:

\[ W_i = \max(w_{\text{min}}, W_i^*) \]

In the context of our model this implies:

\[ W_i = \max(w_{\text{min}}, \beta_0 + \beta_1 \tilde{w}_i + \beta_2 TC_i + \beta_3 (TC \ast \theta) + u_i) \]

Figure 4 gives a clear representation of the type of effects we would expect.

**Standard Censored Tobit Model** A model that is directly relevant here is the Tobit model (Tobin, 1956). We can re-write the above as:

\[ W_i - w_{\text{min}} = \max(0, (\beta_0 + \beta_1 \tilde{w}_i + \beta_2 TC_i + \beta_3 (TC \ast \theta) + u_i) - w_{\text{min}}) \]

To estimate \( \beta \) we assume \( W_i^* \) given the covariates has a homoskedastic normal distribution (i.e. \( u|x \sim \text{Normal}(0, \sigma^2) \)). Since the model is in log transformation, the assumption is more plausible but is still quite strong. We compare these Tobit estimates with a non-parametric alternative in the following section. The advantages of a non-parametric estimator, according to Berg (1998), being that it is robust to non-normality of the error terms and it is robust to heteroskedasticity (which is common in most cross sectional datasets).

**Censored Least Absolute Deviation: Powell’s Estimator** An alternative way to estimate the model, without imposing a structure on the distribution of \( u \)'s is to use Powell’s (1984) censored least absolute deviation (LAD) estimator. Powell’s estimator is restricted to a linear functional form and he shows that the median function \( q_{50}(\beta, \tilde{w}_i, TC_i, (TC \ast \theta)) \) is equal to the function \( \max(w_{\text{min}}, \beta_0 + \beta_1 \tilde{w}_i + \beta_2 TC_i + \beta_3 (TC \ast \theta) + u_i) \), such that: 

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\[ q_{50}(W_i \mid \hat{w}_i, TC_i, (\bar{TC} \ast \theta)) = \max(w_{\min}, q_{50}(\beta_0 + \beta_1 \hat{w}_i + \beta_2 TC_i + \beta_3 (\bar{TC} \ast \theta) + u_i \mid \hat{w}_i, TC_i, (\bar{TC} \ast \theta))) = \max(w_{\min}, \beta_0 + \beta_1 \hat{w}_i + \beta_2 TC_i + \beta_3 (\bar{TC} \ast \theta)) \]

Where \( q_{50} \) denotes the median of the distribution conditional on covariates and the median distribution of \( u_i \) is assumed to be zero. The censored LAD objective is to consistently estimate \( \beta \) by the parameter vector that minimises:

\[ \sum_{i=1}^{N} |W_i - \max(w_{\min}, \beta_0 + \beta_1 \hat{w}_i + \beta_2 TC_i + \beta_3 (\bar{TC} \ast \theta))| \]

The consistency of this estimator does not require knowledge of the distribution of the \( u \)'s, nor is it assumed that the distribution is homoskedastic, only that it has median 0\(^{19}\).

### 5.5 Standard Error Correction of the Predicted Regressor

It may be of some concern as to whether the standard errors and so the inference tests are valid when using the predicted variable, \( \hat{w}_i \). The predicted variable is derived using individual, household and firm characteristics from periods before 1999. We assume the true equation (pre-1999) to be:

\[ w_i = fn(X_i, \alpha) \]

Where \( \hat{w}_i \) is a linear function of \( X_i \) and \( \alpha \). In Stage 1 a consistent estimator for \( \alpha \) is used to obtain, for each observation \( i, \hat{w}_i = fn(X_i, \hat{\alpha}) \). Essentially, the present period set of \( X_i \) are proxied for using \( \hat{w}_i \) and by running the above OLS regression on \( W_i \) we get a consistent estimate for the parameters including \( \beta_1 \).

Since \( p \lim \hat{\alpha} = \alpha \), by the law of large numbers it is reasonable to assume that:

\[ N^{-1} \sum_{i=1}^{N} \hat{w}_i u_i \overset{p}{\rightarrow} E(w_i u_i) \]

\(^{19}\)As pointed out by Deaton (1997), a useful property of quantiles is that they are preserved under monotone transformations. Here, since we have a set of positive observations, ans we take the logarithms, the median of the logarithm of the median of the untransformed data.
Hence the usual OLS assumptions in the population suffice for the two stage procedure to be consistent. What about inference? This question is a little more tricky. Since we use cross sectional data, \( \hat{w}_i \) is constructed using data from a different dataset (i.e. different period to that of the Second Stage). It is not automatically clear how to correct the standard errors since the \( \hat{w}_i \) is neither a straightforward generated regressor, nor a regressor generated from a "Split Sample" as described by Angrist and Krueger (1994).

After much deliberation, we find that the simplest way to ensure the robustness of the standard errors is to conduct what we call a Two Stage Bootstrap: The resampling method of bootstrapping is applied first to the data which generates \( \hat{w}_i \) and then to the final regression(s) in Stage 2.

6 Data & Results

The empirical investigation is done using the UK’s Quarterly Labour Force Survey (LFS). The LFS is a repeated cross-section quarterly survey and it has information on individuals, households and families. This includes, information on employment, earnings and a variety of control variables needed to estimate the (log) wage equation in the first stage. The constructed data set uses data from 15 quarterly LFSs: from 1997 quarter 4 (December-February) to 2003 quarter 1 (March-May), inclusive\(^{20}\). The sample includes women who are aged between 16 and 60 years old. Women in full-time education, sick/disabled or on a government training programme are removed from the sample. In addition, observations of gross wages below £2 and above £60 are excluded. The resulting sample size, after pooling all 15 quarters, is 175,348.

The LFS does contain information on benefit receipt\(^{21}\) but it does not indicate how much WFTC the reported claimant receives (a dummy variable that indicates receipt). In addition to using this indicator in the analysis that follows, data on household income, hours worked, presence of children (i.e. the eligibility

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\(^{20}\) Although data is available beyond this period, WFTC is replaced in April 2003 by the Working Tax Credit.

\(^{21}\) This includes: Family Credit (pre-October 1999), WFTC, Maternity Allowance and Guardian Allowance.
criteria) is used to "roughly" estimate the amount of benefit received (or, at least, how much she is eligible for).

Table 1 presents the descriptive statistics of the characteristics of those who are eligible (i.e. for those who have $WFTC > 0$) and for those who are not eligible (i.e. for those who have $WFTC = 0$). However, it is important to note that these are unmatched and only give the group averages. There are a similar proportion of white workers in the sample (around 95%) and the number working in the public sector is roughly 30-35% for both groups. The non-eligible and eligible tend to have the same mean age of 35-36 years and the tenure is fairly similar at around 30 months. Also the proportion each group being married is around 60%. There are some noticeable differences between the two groups. In particular, the mean hourly wage for the eligible group is £5.80 and for the non-eligible group it is £7.19 and the proportion with no qualifications in the non-eligible group is 11% versus 17% in the eligible group. The number of hours worked is 33.37 hours in the non-eligible group compared with 27.46 hours in the eligible group and (as expected) the eligible have a higher probability of children.

The summary statistics indicate that the eligible group are not identical to the ineligible. This is not a surprise and although we are not solely comparing women with children to those without (as identification comes from various sources of the eligibility criteria), one would expect differences in characteristics. However, for the purpose of this analysis, the most important thing is that the composition of the groups do not change. It can be seen from Table 1 that there is almost no change in the summary statistics for the eligible and ineligible before and after 1999 (the year that both the NMW and WFTC where introduced). As described in the empirical framework, workers are matched on their predicted wages before 1999 and then the change in gross wage is assessed after the introduction of WFTC. As a means of checking that the WFTC variables are representative, Figure 6 uses the WFTC indicator variable to show that as the predicted wage increases, the fraction of claimants fall. In the same way, Figures 7 and 8 show that as the amount of WFTC (rate) falls
as the predicted wage increases and that the fraction of eligible people falls as the predicted wage increases, respectively.

Another pressing issue is that when using the "WFTC Rate" variable, not all assumed eligible are actual claimants. To ensure that this sample of eligible workers is representative of the actual group of claimants, Figure 9 and Figure 10 compares the fraction of recipient families by gross weekly earnings with that of those in the sample. It can be seen that the patterns are fairly similar and so it is probable that the wage distribution is well represented.

6.1 Results

Table 2 presents the OLS, Tobit and Censored LAD estimates for the equations in Section 5.3 using the WFTC dummy variable, WFTC, and the WFTC Rate variable, WFTCrate, respectively. This is done for "All Women" and then sub-groups of "Single Women" and "Married Women". When we look at Panel A, which uses the WFTC variable, there is one very striking and consistent result: the strong and negative spillover effect. This is the case when for all women grouped together as it is for the sub-groups. What this result is essentially telling us is that as the fraction of claimant women increases in the work place, there is a bigger wage fall for everyone in the same skill group (i.e. those with the same predicted wage). This is coherent with the theory laid out in Section 3 where the proposition says that, given the elasticity of substitution, the shift in the burden of the tax incidence increases with the fraction of eligible (claimants).

When comparing the results from the three different estimation techniques, the story remains coherent, the order of magnitude of the coefficients almost halves from an 8% fall when using OLS and Tobit to around 4% when using the Censored LAD.

The results from the WFTC Rate variable in Panel B have the advantage of using the calculated amount

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22 All Standard errors are estimated by drawing 100 bootstrap samples from the original LFS sample.
of WFTC. In this case, the "spillover" effect is estimated using the average WFTC amount in an industry and then weighted by the fraction of eligible in that industry. As with the WFTC dummy variable, the results here seem to indicate that as the average claim, weighted by the fraction of eligible, increases in the industry so does fall in wages of all matched workers (against their predicted wage). Again, the magnitude changes when we use a non-parametric method in the place of the of a parametric method.

The second interesting aspect of these results is that there seem to be evidence that the employer discriminates by cutting the wage of the eligible (claimant) worker relative to the non-eligible when we look at lone mothers. One may expect that since the employer knows that she can cut the gross wage of the eligible worker without reducing the workers net wage, she can share in the incidence. This result is especially interesting since lone mothers are disproportionately the biggest group of claimants and for who WFTC makes up a greater share of household income, the model would predict that this is the group most likely to be effected. The result seems to be significant when using both the WFTC dummy variable and WFTC Rate variable with a fall in the wage of WFTC claimants relative to the non-eligible of 3% and 2%, respectively. However this is not the case when we look at all women grouped together. In the case of the WFTC dummy variable, the coefficient is insignificant and when we use the WFTC Rates variable, the results seem to suggest that the relative wage of an eligible worker actually increased relative to an ineligible worker against the predicted wage by 1.2%. Although this does not coincide with the theory presented, this result seems to be consistent with the result of Lydon &Walker (2005) who look at the before and after WFTC effect on wages and conclude that WFTC promoted incentives to increase investment in on-the-job search and training in general skills and this led to a relative wage growth of eligible workers (who had not previously been eligible under Family Credit) by 2.7%.

Overall the results seem to suggest that work-places with a larger share of WFTC workers (and/or a higher average WFTC amount) will cut the wage of all workers in the same skill group by more than those
with a smaller share. This has an important implication that an increase in WFTC (and claimants) will mean that an employer shares in the benefit of WFTC, extracting the incidence not only from claimants but also from similarly skilled non claimants. We further discuss these results and their policy implications in Section 8.

7 Extensions

In this section, we try to broaden the analysis to investigate some interesting questions. First, does the size of the firm have any impact on the share in incidence between workers and firms? Second, is the WFTC variable endogenous?

7.1 Firm Size

There is a great deal of literature which relates the size of the firm to wages. Brown & Medoff (1989) conclude that one of the main reasons why wages are higher in larger firms is that they hire higher quality workers. So far we have assumed a competitive model and so we would expect that the hourly wages would be the same in all firms, otherwise we would need a model with rents. We try to investigate this proposition by applying the methodology from Section 5 to compare (1) Small sized firms (employing 1-19 workers), (2) Medium sized firms (20-49 workers) and (3) Large sized firms (more than 50 workers).

Table 3 reports the results OLS, Tobit and Censored LAD estimates for each firm size category using the $WFTC^l$ and the $WFTCrate$ variables, respectively. The results seem to indicate that as the size of the firm increases, the degree of "spillover" also increases. If it is the case that larger firms have more uniformity in wage contracts, as there are more people doing identical jobs and receiving the same hourly wage rate, it may be harder for the employer just cut the gross wage of those who are claiming WFTC and to leave the wage of the non claimants unchanged. Instead, the higher spillover effect may indicate that the burden
is shared across all workers and that as the fraction of claimants increases, the cut becomes bigger. The "direct" effect results are a little less conclusive but when looking at the censored LAD estimates seem to suggest that there is a wage cut associated with claiming WFTC, as the model would predict which decreases as the size of the firm increases. Again, this fits the proposition that in smaller firms, where wage contracts are more individualistic in nature, it is "easier" to discriminate when compared to a large firm in which there are many workers with the same characteristics and differentiated only by eligibility.

7.2 Endogeneity of the WFTC Variable

The estimation technique used to derive the WFTC rate variable uses all of the eligibility criteria to match workers as closely as possible on their predicted wages. In the analysis we compare the results from using this variable with the WFTC dummy variable obtained from the LFS. This WFTC dummy variable is the number of reported claimants. Since not all (predicted) eligible people are actual claimants, we have to main concerns: (1) Sample selection in the "take up"/claim of WFTC and (2) Problems with "switchers" and new entrants to WFTC which may distort the sample. Neither of these issues would be a problem if the WFTC dummy variable was exogeneous. In this section, we first discuss these two issues and then try to test the endogeneity of the WFTC dummy variable using the Smith-Blundell (1986) procedure.

7.2.1 Sample Selection in the Take-up Rate

A well known phenomena in any analyse on tax credits is that the take-up rate is not 100% and there is often selectivity associated with who claims. In Brewer (2003) a full literature review is given on the work done to explain non-take up. The main explanations given for why eligible people do not claim their tax credit are that there are distortions in the budget constraint; stigma costs associated with receipt and/or costs of time to proceed with the claim (relative to the gain). Although we know that the WFTC recipients will be
a select group in general, the Two-Stage method used in this paper should control for this by comparing people with the same predicted wage. However we may still be concerned by the sample selection associated with which of the eligible workers actually claim. Assuming that the calculated number of eligible, using the method in Section 5.3, are the correct number of eligible and that those who report claiming WFTC in the LFS do actually claim WFTC the sample selection problem is shown as follows (see Brewer (2003):

Let $N$ indicate receipt of WFTC and as before, let $WFTC^I$ be the number who report claiming WFTC. We have essentially three groups of people:

Eligible recipients: \{$WFTC^I = 1, N > 0$\}

Eligible non-recipients: \{$WFTC^I = 0, N > 0$\}

Non-eligible non-recipients: \{$WFTC^I = 0, N \leq 0$\}

[Possibly a fourth group: Non-eligible recipients: \{$WFTC^I = 1, N \leq 0$\}]

A good measure of take-up, $T$, would be the probability that a truly entitled family receives the tax credit:

$$T = \Pr(WFTC^I = 1| N > 0) = E(T|\Omega) = \frac{\Pr(WFTC^I = 1\& N > 0)}{\Pr(N > 0)}$$

To model the take-up rate, $T$, let:

$$T_i = \gamma Z_i + v_i$$

Where $Z$ is a vector of individual, household and job characteristics\(^{23}\) which determine whether the individual (in the set $N$) is likely to take up the tax credit. Thus:

$$WFTC^I = 1 \text{ if } T_i \geq 0$$

$$WFTC^I = 0 \text{ if } T_i < 0$$

\(^{23}\)See in Section 5.4.1 for a list of these characteristics.
The problem with carrying out a standard Heckman (1984) Two-Step Procedure here is that it is not entirely obvious what the correct instrument would be to include in $Z$, which is not already in $X$. It is not obvious what the In other words, what is correlated with take-up that is not correlated with wages?

7.2.2 Entrants, Switchers & Other Compositional Changes

Throughout the paper we assume that the composition of claimants and non-eligible (and/or non-claimant) remain the same. This is not to say that we assume that the labour supply remained unaltered, given that one of the main aims of the policy is to encourage participation. Instead we were assuming that the average observed and unobserved characteristics in each sub-group remains the same.

However, the entry of previously unemployed or inactive workers may threaten the compositions and/or change in behaviour (modification of characteristics) of a previously ineligible worker to become eligible. For example, the variation for eligibility comes from the presence of children, a low household income and a minimum working hours requirement of 16 hours. Although in the short-run it may be difficult for a worker to adjust the former two factors to become eligible, she can (possibly) alter the household hours of work to maximise a gain from WFTC or moreover, to even secure eligibility..

According to Battistin and Rettore (2003) if there is an entry effect, stronger conditions for identification are needed. We can test to see if entry/switching alter the compositions using the Five Quarter (LFS) Longitudinal Dataset (quarter 4 1998 to quarter 4 1999). Using a panel data set framework, we can estimate the wage growth of workers, controlling for the factors that determine eligibility as well as all the other controls used in the analysis. We expect that the wage growth will be low for those receiving WFTC

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24 $X$ is the vector set used to find the predicted wage, $\hat{w}$.
25 This 3 quarters give one quarter before the introduction of NMW and WFTC and then one quarter after the introduction of both.
but who were not previously.

Again, this is another issue that would not be a problem if the WFTC dummy variable was exogenous.

### 7.2.3 Endogeneity Test for the WFTC Variable: Smith-Blundell Procedure

If it is the case that the \( WFTC \) variable is endogenous in the censored regression model, such that:

\[
W_i = \max\left( w_{\text{min}}, \beta_0 + \beta_1 \hat{w}_i + \beta_2 WFTC_i + \beta_3 (WFTC \ast \theta) + u_i \right)
\]

Where \( WFTC_i = \alpha_0 + \alpha_1 \hat{w}_i + \alpha_2 HHInc_i + \alpha_3 Hours_i + \alpha_4 Children_i + v_i \)

In the \( WFTC_i \) equation we know that the latter three explanatory variables are part of the eligibility criteria and since both household income, \( HHInc \), and hours worked, \( Hours \), are potentially endogenous, for identification we assume that the presence of children, \( Children \), is exogenous. For identification we need the rank condition \( \alpha_4 \neq 0 \).

In this section we use a two-step procedure proposed by Smith and Blundell (1986) that will delivers a simple test for the endogeneity of the WFTC variable. Under bivariate nomality of \( (u, v) \) we can write:

\[
u_i = \phi v_i + e_i
\]

Where \( \phi = \eta/\tau^2, \eta = Cov(u, v), \tau^2 = Var(v) \), and \( e \) is independent of \( v \) with zero mean normal distribution and variance, say \( \tau_1^2 \). Further, because \( (u, v) \) are independent of \( \hat{w}_i \), \( e \) is independent of \( (\hat{w}_i, v) \). Thus plugging this into the Tobit gives:

\[
W_i = \max\left( w_{\text{min}}, \beta_0 + \beta_1 \hat{w}_i + \beta_2 WFTC_i + \beta_3 (WFTC \ast \theta) + \phi v_i + e_i \right)
\]

where \( e | \hat{w}_i, v \sim \text{Normal}(0, \tau_1^2) \). It follows that, if we knew \( v \) we could estimate all coefficients by standard censored Tobit. Since we don’t we follow the Smith-Blundell procedure such that: (a) Estimate the reduced form of \( TC \) by OLS; this step gives \( \hat{\alpha} \). Define the reduced-form OLS residual as \( \hat{v}_i = WFTC_i - \hat{\alpha}_0 - \hat{\alpha}_1 \hat{w}_i - \hat{\alpha}_2 HHInc_i - \hat{\alpha}_3 Hours_i - \hat{\alpha}_4 Children_i \). (b) Estimate a standard Tobit of \( W_i \) on \( \hat{w}_i, WFTC_i \) and \( \hat{v}_i \).
Table 4 shows that since $v_i$ is insignificant, there is little evidence to suggest that the WFTC variable is endogenous in the equation\(^{26}\).

### 8 Discussion & Policy Implications

The main aim of this paper was to analyse the impact of a tax credit on wages in a general equilibrium framework. By using this set-up we could encapsulate the effect on the economy as a whole and not solely on the claimant. Moreover we accounted for how changes in the design of the policy altered modelling assumptions. For example, the WFTC differed from Family Credit (its predecessor) in that it was paid through the wage packet and this in turn altered the amount of information to the employer.

The results presented in Section 6 imply that there is a significant shift in the burden of tax credits, in line with the theory presented. This is of critical policy importance as we can no longer assume that it is the case that the person eligible for such a tax credit is the sole beneficiary. In particular, the main results imply that as the fraction of claimants rises in the workplace, there is a 2-3\% fall in the wage (given the predicted wage) for both eligible (claimants) and similarly skilled non eligible workers.

These results are important in their own right since they highlight the consequences of the expansion, application and generosity of tax credits. However, in the case of the UK they are important with respect to the new changes in tax credit policy. In April 2003 the government’s new tax credit (Child Tax Credit and Working Tax Credit) was introduced. Essentially the new system divides the old WFTC into these two parts. Child Tax Credit is paid to low income families with children, regardless of whether the parents are in work. The Working Tax Credit, on the other hand, works in a similar way to WFTC (i.e. contingent on working a minimum of 16 hours and earning below a certain threshold) but unlike WFTC, the Working Tax

\(^{26}\)Under $\phi = 0, \epsilon = u$, normality of $v$ plays no role: as a test for endogeneity of $WFTC^I$, the Smith-Blundell approach is valid without any distributional assumptions on the reduced form of $WFTC^I$. 

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Credit is not just restricted to those with children. The idea is to make work pay for non-parents as well as parents. The important implication here is that the strong negative "spillover" may persist.

In addition, it may be interesting to look closer at the institutional role with regard to extracting tax credit incidence. In the case of minimum wages, it has been discussed that they act as a barrier such that they reduces the power of the employer to cut the gross wage. Perhaps looking at the public versus private sector and/or unionised versus non-unionised firms can help to shed some more light on whether institutions either prevent or encourage the employer to extract the tax credit incidence.

9 Conclusion

The increased use of tax credits as a method of "in work benefits" has raised a great deal of popular interest in the UK and in many other countries where they have been initiated. The move to integrate the social security system within the tax system was favoured as a means to reward people who are in work and to "make work pay". This paper focuses on looking at the indirect consequences of such a policy by focusing on the effect on gross equilibrium wages in the UK following the introduction of the Working Families’ Tax Credit in October 1999. There is evidence to suggest that the employer does share in the incidence of the tax credit by cutting the wage of all similarly skilled workers as the fraction of claimants in the work-place increases. Moreover, when looking at lone mothers there is evidence to suggest that the employer does cut the gross wage of the claimant worker relative to the ineligible worker (who has the same predicted wage). This discriminatory behaviour may be explained by the fact that lone mothers are disproportionately the largest group of claimants and for who the WFTC makes up a greater share of household income. In addition, there is evidence to suggest that the size of the firm may play a vital role. As the size of the firm increases, the spillover effect is stronger and the direct effect is weaker. This may suggest that as the size of the firm
increases, the burden of the tax credit is shared more equally across workers with similar characteristics.

Overall the most consistent result of this paper is a strong negative "spillover" effect. We may expect that this effect will become the dominant effect, if not the only effect, with the introduction of the Working Tax Credit in April 2003 which extends its entitlement to workers without children.
References


Figure 1: FC/WFTC RECIPIENTS BY FAMILY TYPE, MAY 1988 - NOVEMBER 2002*

Figure 2: AVERAGE FC/WFTC WAWARD BY FAMILY TYPE, MAY 1988 - NOVEMBER 2002*

Figure 3: DISTORTION BETWEEN ACTUAL & PREDICTED WAGES AFTER THE INTRODUCTION OF THE NMW
Figure 4: SPILLOVER EFFECT

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<thead>
<tr>
<th>Binding NMW (MAX)</th>
<th>Non-Binding NMW (MIN)</th>
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<td>£3.60</td>
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WFTC eligible
WFTC ineligible
**Figure 5: FRACTION CLAIMING WFTC BY PREDICTED WAGE**

![Graph showing the fraction claiming WFTC by predicted wage.](image-url)
Figure 6: AVERAGE WFTC RATE BY HOURLY PREDICTED WAGE
Figure 7: FRACTION ELIGIBLE FOR WGFTC BY PREDICTED HOURLY WAGE
Figure 8: FRACTION OF RECIPIENT EARNING BRACKETS (GROSS WEEKLY) - ALL CASES
Figure 9: FRACTION OF RECIPIENT EARNING BRACKTS (GROSS WEEKLY) - LONE PARENTS
TABLE 1: DESCRIPTIVE STATISTICS

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<tr>
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<th>Ineligible Before 1999</th>
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<td>0.95 [0.22]</td>
<td>0.95 [0.22]</td>
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<tr>
<td>No Qualifications</td>
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<td>0.14 [0.34]</td>
<td>0.11 [0.31]</td>
<td>0.10 [0.29]</td>
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<tr>
<td>Public Sector</td>
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<td>0.35 [0.47]</td>
<td>0.37 [0.48]</td>
<td>0.37 [0.48]</td>
</tr>
<tr>
<td>Married</td>
<td>0.54 [0.49]</td>
<td>0.53 [0.49]</td>
<td>0.74 [0.44]</td>
<td>0.72 [0.45]</td>
</tr>
<tr>
<td>Tenure</td>
<td>33.91 [29.17]</td>
<td>33.03 [27.77]</td>
<td>32.63 [28.66]</td>
<td>32.57 [27.52]</td>
</tr>
<tr>
<td>Experience</td>
<td>90.23 [90.49]</td>
<td>90.79 [93.06]</td>
<td>66.11 [69.44]</td>
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<td>30%</td>
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<td>31%</td>
<td>30%</td>
</tr>
<tr>
<td>% in Medium Firms</td>
<td>19%</td>
<td>26%</td>
<td>23%</td>
<td>28%</td>
</tr>
<tr>
<td>% in Large Firms</td>
<td>51%</td>
<td>45%</td>
<td>46%</td>
<td>42%</td>
</tr>
<tr>
<td>Observations</td>
<td>26604</td>
<td>77930</td>
<td>18253</td>
<td>53673</td>
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### TABLE 2: STAGE TWO (BASIC) REGRESSION RESULTS

#### A - WFTC (LFS)

<table>
<thead>
<tr>
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<th>ALL</th>
<th>SINGLE</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>Tobit</td>
<td>C-LAD</td>
</tr>
<tr>
<td>Predicted wage</td>
<td>0.99 [0.003]**</td>
<td>1.003 [0.003]**</td>
<td>1.025 [0.003]**</td>
</tr>
<tr>
<td>WFTC Dummy</td>
<td>0.007 [0.005]</td>
<td>0.004 [0.005]</td>
<td>-0.01</td>
</tr>
<tr>
<td>Spillover</td>
<td>-0.078 [0.008]**</td>
<td>-0.084 [0.009]**</td>
<td>-0.038</td>
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<tr>
<td>Constant</td>
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<td>-0.056 [0.008]**</td>
<td>-0.129</td>
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<tr>
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<td>Yes</td>
<td>Yes</td>
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<tr>
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#### B - WFTC Rate

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</tr>
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<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>Tobit</td>
<td>C-LAD</td>
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<tr>
<td>Predicted wage</td>
<td>0.996 [0.003]**</td>
<td>1.008 [0.003]**</td>
<td>1.026 [0.004]**</td>
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<td>0.048 [0.005]**</td>
<td>0.012</td>
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<tr>
<td>Spillover</td>
<td>-0.131 [0.013]**</td>
<td>-0.144 [0.016]**</td>
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<td>-0.013 [0.020]</td>
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# TABLE 3: STAGE TWO REGRESSION RESULTS – FIRM SIZE

## A - WFTC (LFS)

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<th>LARGE</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Tobit</td>
<td>C-LAD</td>
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<tr>
<td>Predicted wage</td>
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<td>1.007</td>
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<tr>
<td></td>
<td>[0.008]**</td>
<td>[0.007]**</td>
<td>[0.008]**</td>
</tr>
<tr>
<td>WFTC Dummy</td>
<td>-0.002</td>
<td>-0.009</td>
<td>-0.027</td>
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<td></td>
<td>[0.008]</td>
<td>[0.009]</td>
<td>[0.010]**</td>
</tr>
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<td>Spillover</td>
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<td>[0.019]*</td>
<td>[0.016]*</td>
<td>[0.019]**</td>
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<td></td>
<td>[0.026]</td>
<td>[0.016]*</td>
<td>[0.019]**</td>
</tr>
<tr>
<td>Year Dummies</td>
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<td>Yes</td>
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## B - WFTC Rate

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<td>C-LAD</td>
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<td>[0.009]**</td>
<td>[0.008]**</td>
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<td>-0.001</td>
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<td></td>
<td>[0.009]**</td>
<td>[0.011]**</td>
<td>[0.008]</td>
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<td>-0.001</td>
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<tr>
<td></td>
<td>[0.028]</td>
<td>[0.003]**</td>
<td>[0.019]**</td>
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<td>22244</td>
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<td></td>
<td>Tobit: Stage 2</td>
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<tr>
<td>------------------</td>
<td>----------------</td>
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<tr>
<td>Predicted wage</td>
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</tr>
<tr>
<td></td>
<td>[0.004]**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WFTC Dummy</td>
<td>-0.017</td>
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<tr>
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<td>[0.015]</td>
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1 Appendix A

1.1 PROOFS FROM SECTION 3:

1.1.1 Proof 1:

Let labour demand equal labour supply:

\[ N^d(w(s)) = N_1^s(w(s)(1 + s) + N_2^s(w(s)) \]

Differentiate with respect to \( s \):

\[
\frac{\partial N^d}{\partial w} \frac{\partial w}{\partial s} = \left[ \frac{\partial N_1^s}{\partial w} \frac{\partial w}{\partial s} + \frac{\partial N_2^s}{\partial w} \frac{\partial w}{\partial s} \right] + \frac{\partial N_2^s}{\partial w} \frac{\partial w}{\partial s}
\]

Since:

\[ N^d = N_1^s + N_2^s \]

Re-write the above results:

\[
\frac{w}{N^d} \frac{\partial N^d}{\partial w} = \frac{1 + \frac{1 + s}{w}}{\frac{\partial \ln w}{\partial \ln(1 + s)}} \frac{\partial \ln w}{\partial \ln(1 + s)} + \frac{w}{N^d} \frac{\partial N_2^s}{\partial w} \frac{\partial w}{\partial s}
\]

Let:

\[ \theta = \frac{N_1^s}{N_1^s + N_2^s} \]

And so:

\[
\frac{w}{N^d} \frac{\partial N^d}{\partial w} = \theta \frac{\partial N_1^s}{\partial w} \frac{w}{w^d} + \left[ \frac{1 + \frac{1 + s}{w}}{\frac{\partial \ln w}{\partial \ln(1 + s)}} \right] + (1 - \theta) \frac{\partial N_2^s}{\partial w} \frac{w}{w^d} \frac{1}{w} \frac{\partial w}{\partial s}
\]

\[
\eta_1^d \frac{\partial \ln w}{\partial \ln(1 + s)} = \theta \eta_1^d \left[ 1 + \frac{\partial \ln w}{\partial \ln(1 + s)} \right] + (1 - \theta) \eta_2^d \frac{\partial \ln w}{\partial \ln(1 + s)}
\]

\[
\left( \eta_1^d - \theta \eta_1^d - (1 - \theta) \eta_2^d \right) \frac{\partial \ln w}{\partial \ln(1 + s)} = \theta \eta_1^d
\]

\[
\frac{\partial \ln w}{\partial \ln(1 + s)} = \frac{\theta \eta_1^d}{\eta_1^d - (1 - \theta) \eta_2^d - \eta_1^d}
\]

\[
\frac{\partial \ln w}{\partial \ln(1 + s)} = \frac{\theta \eta_1^d}{\eta_1^d + (1 - \theta) \eta_2^d - \eta_1^d}
\]
1.1.2 Proof 2: Proposition

Assume a general equilibrium model with two types of labour $i$. Where $i = 1, 2$.

Labour is the only factor of production and labour demand for each factor is given by:

$$N^d_i(w_1, w_2) \text{ and } N^d_2(w_1, w_2)$$

The production of one good, $X$, occurs in a constant return to scale environment:

$$X = F[N_1, N_2]$$

The model is developed using equations of change (i.e. using the log-linearisation method of Jones (1965)). Fully differentiate to get:

$$dX = F_N_1 dN_1 + F_N_2 dN_2$$

Where $F_N_i$ is the marginal product for $i = 1, 2$.

Divide through by $X$:

$$\frac{dX}{X} = \frac{F_N_1}{X} \frac{dN_1}{N_1} + \frac{F_N_2}{X} \frac{dN_2}{N_2}$$

Let $\theta$ be the factor share for group 1 and $w_1$ be the factor payment (gross wage) for group 1 such that:

$$\theta = \left( \frac{w}{pX} \right) \frac{N_1}{X} \text{ s.t } w = pX F_N_1$$

Let $(1 - \theta)$ be the factor share for group 2 and $w_2$ be the factor payment (gross wage) for group 2 such that:

$$(1 - \theta) = \left( \frac{w}{pX} \right) \frac{N_2}{X} \text{ s.t } w = pX F_N_2$$

And so:

$$\frac{dX}{X} = \theta \frac{dN_1}{N_1} + (1 - \theta) \frac{dN_2}{N_2}$$

$$X = \theta N_1 + (1 - \theta)N_2$$

The elasticity of subsitution between the two groups can be given by:

$$\sigma_X = \frac{d \left( \frac{N_1}{N_2} \right) / \left( \frac{N_1}{N_2} \right)}{d \left( \frac{w_1}{w_2} \right) / \left( \frac{w_1}{w_2} \right)}$$

Where the differentiation in the numerator is:

$$\frac{N_2 dN_1 - N_1 dN_2}{N_2^2} \cdot \frac{N_2}{N_1} = \frac{dN_1}{N_1} - \frac{dN_2}{N_2} = \dot{N}_1 - \dot{N}_2$$
And so (with a similar differentiation to the denominator):

\[
\sigma_X = \frac{N_1 - N_2}{w_2 - w_1} \\
N_1 - N_2 = \sigma_X (w_2 - w_1)
\]

So far, the resulting system of equations are given by:

1. \[N_1 - N_2 = \sigma_X (w_2 - w_1)\]
2. \[X = \theta N_1 + (1 - \theta) N_2\]

The value of output in each industry must equal the factor payment:

3. \[p_X X = w_1 N_1 + w_2 N_2\]

Where \(p_X\) is normalised to 1.

\[
\frac{dw_2}{w_2} = -dw_1 \frac{N_1}{N_2} \\
\frac{dw_2}{w_2} = -dw_2 \frac{N_1 w_1}{w_2 N_2 w_2} \\
w_2 = -w_1 \frac{N_1 w_1 / p_X X}{N_2 w_2 / p_X X} \\
w_2 = -\left(\frac{\theta}{1-\theta}\right) w_1
\]

Substitute into (1):

\[
\dot{N}_1 - \dot{N}_2 = \sigma_X (-\left(\frac{\theta}{1-\theta}\right) \dot{w}_1 - \dot{w}_1) \\
\dot{N}_1 - \dot{N}_2 = -\frac{\sigma_X}{1-\theta} \dot{w}_1
\]

Turning now to the labour supply of each group. It is here that the tax credit is incorporated because the tax is placed on the worker rather than on the employer (such that the gross wage is \(w\) and the net wage is \(w(1 + s)\)).

The budget constraint for the eligible worker (group 1) is given by:

4. \[p_X X = w_1 (1 + s) N_1 + M\]

Where \(M\) is non-labour income and for convenience we set this to zero.

Totally differentiate and evaluate at \(s = 0\) to get:

\[
X = \theta (\dot{w}_1 + s + \dot{N}_1)
\]
To adapt Harberger’s two-sector model, let "good" Y be interpreted as the leisure produced by the production function. The price of leisure for is the net wage rate \((p_Y = w_1(1 + s))\).

\[(5) N_1 + Y = \tilde{N}_1\]

This is the fixed total supply. Totally differentiate:

\[\lambda_{XN_1} N_1 + \lambda_{YN_1} Y = 0\]
\[Y = -\frac{\lambda_{XN_1}}{\lambda_{YN_1}} N_1 = -\phi N_1\]

Where \(\lambda_{jN_1}\) is the fraction of labour (group 1) used in the production of \(j = X, Y\) and \(\phi\) is the ratio of labour to leisure.

As in the Harberger two sector model, the elasticity of substitution (in demand) is given by:

\[X - \dot{Y} = \sigma_D (p_Y - p_X)\]
\[X + \phi N_1 = \sigma_D (w_1 + \dot{s})\]

Plug this into (4):

\[\sigma_D (w_1 + \dot{s}) - \phi \dot{N}_1 = \theta (w_1 + \dot{s} + \dot{N}_1)\]
\[(\sigma_D - \theta) (w_1 + \dot{s}) = (\theta + \phi) \dot{N}_1\]
\[\dot{N}_1 = \frac{(\sigma_D - \theta)}{(\theta + \phi)} (w_1 + \dot{s})\]

Analogous for the ineligible group (group 2):

\[(4') p_X X = w_2 N_2 + M\]
\[X = (1 - \theta)(w_2 + \dot{N}_2)\]
\[(5') N_2 + Y = \tilde{N}_2\]
\[\dot{N}_2 = \frac{(\sigma_D - (1-\theta))}{((1-\theta) + \phi)} w_2\]

Finally, the relative Labour supply is given by:

\[\dot{N}_1 - \dot{N}_2 = \eta_1^\phi (w_1 + \dot{s}) - \eta_2^\phi w_2\]

Where \(\eta_1^\phi = \frac{(\sigma_D - \theta)}{(\theta + \phi)}\) and \(\eta_2^\phi = \frac{(\sigma_D - (1-\theta))}{((1-\theta) + \phi)}\).

The equilibrium is, therefore, given by:
\[ N_1 - N_2 = -\frac{\sigma_X}{(1-\theta)} \cdot \dot{w}_1 \]
\[ \eta_1^s(\dot{w}_1 + \dot{s}) - \eta_2^s \cdot \dot{w}_2 = -\frac{\sigma_X}{(1-\theta)} \cdot \dot{w}_1 \]
\[ \eta_1^s(\dot{w}_1 + \dot{s}) - \eta_2^s \cdot \dot{w}_2 = \eta^d \cdot \dot{w}_1 \]

Where \( \eta^d = -\frac{\sigma_X}{(1-\theta)} \cdot \dot{w}_1 \).

\[ \eta_1^s(\dot{w}_1 + \dot{s}) + \left( \frac{\theta}{(1-\theta)} \right) \eta_2^s \cdot \dot{w}_1 = \eta^d \cdot \dot{w}_1 \]
\[ (\eta_1^s + \left( \frac{\theta}{(1-\theta)} \right) \eta_2^s - \eta^d) \cdot \dot{w}_1 = -\eta_1^s \cdot \dot{s} \]
\[ \frac{\dot{w}_1}{\dot{s}} = \frac{-\eta_1^s}{\left( \eta_1^s + \left( \frac{\theta}{(1-\theta)} \right) \eta_2^s \right) - \eta^d} \]
\[ \frac{\dot{w}_1}{\dot{s}} = \frac{(1-\theta)\eta_1^s}{\left( (1-\theta)\eta_1^s + \theta \eta_2^s - (1-\theta)\eta^d \right)} = \frac{(1-\theta)\eta_1^s}{\left( (1-\theta)\eta_1^s + \theta \eta_2^s + \sigma_X \right)} \]

Since \( \dot{w}_2 = -\left( \frac{\theta}{(1-\theta)} \right) \cdot \dot{w}_1 \), for group 2:

\[ \frac{(1-\theta)}{\theta} \cdot \frac{\dot{w}_2}{\dot{s}} = \frac{(1-\theta)\eta_1^s}{\left( (1-\theta)\eta_1^s + \theta \eta_2^s - (1-\theta)\eta^d \right)} = \frac{(1-\theta)\eta_1^s}{\left( (1-\theta)\eta_1^s + \theta \eta_2^s + \sigma_X \right)} \]
\[ \frac{\dot{w}_2}{\dot{s}} = \frac{\theta \eta_1^s}{\left( (1-\theta)\eta_1^s + \theta \eta_2^s + \sigma_X \right)} \]
0.1 CHANGES IN NMW, WFTC & AVERAGE EARNINGS:
TABLE A1: NATIONAL MINIMUM WAGE (ARCHIVED RATES)*

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<th>Aged 22 years &amp; older</th>
<th>1st April 1999 to 30th September 2000</th>
<th>£3.60</th>
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<td>1st October 2000 to 30th September 2001</td>
<td>£3.70</td>
</tr>
<tr>
<td></td>
<td>1st October 2001 to 30th September 2002</td>
<td>£4.10</td>
</tr>
<tr>
<td></td>
<td>1st October 2002 to 30th September 2003</td>
<td>£4.20</td>
</tr>
<tr>
<td>Aged 18 - 21 years, inclusive</td>
<td>1st April 1999 to 30th May 2000</td>
<td>£3.00</td>
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<td></td>
<td>1st June 2000 to 30th September 2001</td>
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<td></td>
<td>1st October 2001 to 30th September 2002</td>
<td>£3.50</td>
</tr>
<tr>
<td></td>
<td>1st October 2002 to 30th September 2003</td>
<td>£3.60</td>
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</tbody>
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* HM Revenue & Customs: National Minimum Wage

* Office of National Statistics
**TABLE A2: WORKING FAMILIES’ TAX CREDIT RATES & THRESHOLDS, 1999-2003**

<table>
<thead>
<tr>
<th></th>
<th>1999-00</th>
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<th>2001-02</th>
<th>2002-03</th>
</tr>
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<tbody>
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<td><strong>BASIC TAX RATE</strong></td>
<td>£ per week</td>
<td>52.3</td>
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<td>59</td>
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<td><strong>30 HOUR TAX CREDIT</strong></td>
<td>£ per week</td>
<td>11.05</td>
<td>11.25</td>
<td>11.45</td>
</tr>
<tr>
<td><strong>PER CHILD CREDIT</strong></td>
<td>£ per week</td>
<td>20.9</td>
<td>25.6</td>
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<tr>
<td><strong>REDUCTION INCOME THRESHOLD</strong></td>
<td>£ per week</td>
<td>90</td>
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<td><strong>INCOME TAPER</strong></td>
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<td>55%</td>
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<td><strong>MINIMUM AWARD</strong></td>
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<td>0.5</td>
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* Working Families’ Tax Credit Statistic, Inland Revenue Summary Statistics (Feb 2003)

**FIGURE A1: AVERAGE EARNING INDEX FOR THE WHOLE ECONOMY**

[Graph showing average earning index for the whole economy from 1998-Q4 to 2003-Q4.]