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Earned income tax credits, unemployment benefits and wages: empirical evidence from Sweden

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Abstract

Although there is a large literature on employment effects of earned income tax credits (EITCs) and unemployment benefits, less is known about wage effects. In our model, the impact is via the net (after-tax) replacement rate. Using a panel of individuals from Sweden, we find a positive relationship between the net replacement rate and wages with semi-elasticities in the range 0.2-0.4. This implies that a one per cent reduction in the unemployment benefit level or a one per cent increase in the net-of-tax rate is associated with a fall in the before-tax wage of 0.1-0.2 per cent. EITCs and unemployment benefit reductions are thus likely to induce wage moderation.

JEL-codes: J31; J38; H24

Keywords: Earned income tax credit; Unemployment benefits; Wage formation

1 Introduction

Starting in the mid-1980s, labour market reforms have been implemented in many developed economies with the aim of reducing unemployment and raising employment in the longer term. The reforms have often involved reductions in the generosity of unemployment insurance and the introduction of earned income tax credits (EITCs), i.e. tax reductions on income from employment only, in order to increase the return to work. A large amount of empirical research has studied the impact on unemployment and employment. However, although theoretical models usually identify wage reductions as the crucial mechanism through which employment is influenced, there has been surprisingly little research on wage effects. The aim of this paper is to help fill this gap.

Empirical studies of how unemployment benefits influence unemployment are of two types: microeconometric studies of the duration of unemployment and panel studies trying to explain unemployment differences both across and within countries over time. But the number of studies of how benefits influence individuals' reservation wages is small compared to the number of studies of the effects on unemployment duration, as noted by Shimer and Werning (2007). Most of the studies are old. Some of them, such as Lynch (1983), Holzer (1986), van den Berg (1990) and Bloemen and Stancanelli (2001), find quite small elasticities of reservation wages with respect to benefits (0.1 or smaller), whereas a couple of others (Fishe 1982 and Feldstein and Poterba 1984) estimate substantially larger elasticities. Macroeconomic panel studies seldom examine the relation between unemployment benefits and wages[1] but instead estimate reduced-form relationships between unemployment and other variables including unemployment benefits (see, e.g., Bassanini and Duval 2009).

The situation is similar with respect to EITCs. Many studies - mainly for the US - have exploited the natural experiment that only some groups (mainly single mothers) have received the tax credit. Using difference-in-differences techniques, large employment effects on the extensive margin (the number of employed persons) have been identified (see e.g. Hotz and Scholz 2003 and Eissa and Hoynes 2006). The effects have been interpreted as labour supply effects even though higher labour force participation can be translated into higher employment only if wages fall such that an increased labour demand is forthcoming. Indeed, a few studies, including Rothstein (2008), Azmat (2009) and Leigh (2010), have found that EITCs cause substantial wage reductions. Rothstein finds that low-skilled mothers in the US keep only 70 per cent of every dollar they receive in EITC because of wage falls. Azmat comes up with a similar estimate for male claimants of the Working Family Tax Credit in the UK. Leigh's finding is that a 10 per cent increase in the generosity of the EITC in the US causes wage reductions of 5 per cent for high-school drop-outs and 2 per cent for those with only a high-school diploma.

In standard labour supply-demand models, general-equilibrium wage reductions attenuate the employment effects that would follow from partial-equilibrium supply-side effects (increased labour force participation), as stressed by Rothstein (2008, 2010). However, as Kolm and Tonin (2011) show, this result need not hold in a Mortensen-Pissarides search-matching model. The job creation induced by the wage fall, because it becomes more profitable for firms to open up vacancies, may increase the expected value of entering the labour force since unemployment spells are shortened.

EITCs have often been introduced with the double objective of raising employment and alleviating poverty. To the extent that the EITCs' incidence is on employers by reducing wages, the measure's efficiency in achieving both targets is reduced. Instead, a trade-off emerges: the more effective an EITC is in raising employment through wage reductions, the less effective it is in raising the living standards of the recipients (Rothstein 2010; Swedish Fiscal Policy Council 2010).

Our paper examines the effects of unemployment benefits and EITCs on wages by using micro data from Sweden for 2004-2009. This period encompassed large reductions in the generosity of unemployment benefits as well as the introduction (and expansion) of an EITC in 2007-2009. Since all wage earners are eligible for the EITC in Sweden, it is not possible to differentiate between groups who have received the tax credit and groups who have not. Instead, we exploit variations in the size of the tax credit between individuals. We employ a search-matching framework according to which both unemployment benefits and EITCs influence wages through their effect on the net replacement rate (the ratio between after-tax incomes of unemployed and employed workers). Our set-up also allows us to study the wage effects of income tax progressivity and payroll taxes.

In most of our estimations, we find a significantly positive relationship between the net replacement rate and the wage. This implies that a reduction in unemployment benefits and an EITC tend to reduce wages. As in the wage studies for the US and the UK quoted above, the magnitude is substantial: a one percentage point lower net replacement rate is associated with lower nominal wages in the order of magnitude of 0.2-0.4 per cent. This means that a one per cent decrease in the unemployment benefit level or a one per cent increase in the net-of-tax rate is associated with a wage fall of 0.1-0.2 per cent. We also find that higher income tax progressivity is associated with lower wages, although the size of the effects is more unstable here: some estimates suggest small effects, whereas others suggest substantial ones. We find little evidence of wage effects of payroll tax changes. Overall, our estimations suggest that wage reductions are likely to be an important mechanism through which EITCs and lower unemployment benefits influence the labour market.

The paper is structured as follows. Section 2 describes the reforms relevant to wage formation in Sweden in 2007-2009. Section 3 presents the theoretical framework. Section 4 outlines our empirical strategy. Section 5 describes the data. Section 6 presents empirical results. Section 7 concludes.

2 Swedish labour market reforms

The majority of Swedish wage earners are eligible for an income-dependent unemployment benefit administered by unemployment insurance funds. Prior to 2007, the before-tax replacement rate was 80 per cent for those with a wage income below a ceiling and above a floor. From 2007, the replacement rate was made dependent on unemployment duration. An unemployed worker with a previous income between the floor and the ceiling now faces a before-tax replacement rate of 80 per cent for the first 200 days. After 200 days, the replacement rate drops to 70 per cent for the next 100 days (250 days for parents of minors). After that, an unemployed worker receives 65 per cent of the earlier wage indefinitely within a labour market programme: the job and activity guarantee. The implication is a gradually falling replacement rate over an unemployment spell. Earlier, the maximum benefit level for the first 100 days of unemployment was SEK 730, but it was reduced to SEK 680 from 2007 so that the maximum benefit level is now the same throughout the unemployment spell. Since the maximum benefit levels have been fixed in nominal terms since 2002 (with the exception of the cut described above), there has been a gradual reduction in the replacement rate for high-income earners when their wages have increased. The minimum daily unemployment benefit has also been held constant (at SEK 320) since 2002, so those obtaining it (low-income earners and those who are not members of an insurance fund) have also experienced a gradual fall in the replacement rate.[2]

An EITC was introduced in 2007 and subsequently expanded in 2008 and 2009. All working individuals automatically receive a tax reduction on income from employment, regardless of civil status or number of children in the household. The credit implies that income below a threshold is tax exempt, while income above it is taxed less than earlier. The magnitude of the tax credit depends on income from employment, a basic amount that is indexed to inflation, tax rates in the municipality of residence and the general tax deduction that the individual is entitled to, which in turn is based on total income. The design implies that the EITC is phased in up to an annual earnings level of SEK 318,000 (€ 34,000). Above this level, the credit stays constant, so there is no phasing out. As a share of income, low-income earners have received the largest tax cuts.[3]

Large reductions in payroll taxes for young people have also been implemented. In 2007, the payroll tax rate for those below 25 was reduced from 32.4 to 21.3 per cent. There was an additional payroll tax cut from 21.3 to 15.5 per cent in 2009, and the reductions were then extended also to 25-year-olds.

3 Theoretical framework

We use a search-matching model of the Mortensen-Pissarides type. It is a simplified version of such a model with taxes as presented in Cahuc and Zylberberg (2004).[4] We consider an economy that consists of a large number of identical firms and workers. Firms produce a homogenous good using labour as the only input. Each firm has one job slot, which can be filled or vacant. The government levies income taxes on labour and payroll taxes on firms. Unemployed workers search for employment, and the number of successful matches depends on the number of vacancies posted by firms and the number of unemployed workers competing for jobs. Wages are set in Nash bargaining between workers and firms.

Let the discounted values for a worker being employed and being unemployed be denoted by V_E and V_U, respectively. Variables with the superscript i refer to firm i and variables without a superscript to employment in some other firm. The flow value functions for a worker in firm i and for an unemployed worker are then:

$$rV_E^i = \omega_E^i + q\left(V_U - V_E^i\right) \tag{1}$$

$$rV_U = b + s(\theta)(V_E - V_U), \tag{2}$$

where r is the exogenous discount rate, q is the exogenous job destruction rate, b is the after-tax real unemployment benefit, and s is the hazard rate, i.e., the rate at which unemployed workers exit unemployment, which depends positively on labour market tightness θ (the ratio between the number of vacancies and the number of unemployed) so that $s'(\theta) > 0$. $\omega_E^i = w^i - T_E(w^i)$ is the after-tax real wage of a worker in firm i, with w^i being the pre-tax real wage and T_E the income tax paid by the worker.

Let Π_E^i and Π_V^i denote the values of firm i's profit streams associated with employment of a worker and an unfilled vacancy, respectively. Then the following asset return equations apply:

$$r\Pi_E^i = y - \omega_F^i + q\left(\Pi_V^i - \Pi_E^i\right) \tag{3}$$

$$r\Pi_V^i = -h + m(\theta)\left(\Pi_E^i - \Pi_V^i\right), \tag{4}$$

where y is output per worker, h is the cost of a vacancy and m is the probability of filling a vacancy, which depends negatively on labour market tightness θ so that $m'(\theta) < 0$. $\omega_F^i = (1+\tau)w^i$ is the real wage cost of a worker to firm i, with τ being a proportional payroll tax rate.

Letting $\lambda \in (0,1)$ denote the relative bargaining power of workers, the Nash bargaining solution for the real wage in firm i is obtained by solving:

$$\max_{lnw^i} \Lambda = \lambda ln\left(V_E^i - V_U\right) + (1-\lambda) ln\left(\Pi_E^i - \Pi_V^i\right),$$

where (1) implies

$$V_E^i - V_U = \frac{\omega_E^i - rV_U}{r+q} \ . \tag{5}$$

Since free entry of firms ensures that $\Pi_V^i = 0$, (3) gives:

$$\Pi_E^i - \Pi_V^i = \frac{y - \omega_F^i}{r+q}. \tag{6}$$

Taking account of (5) and (6) and solving the optimization problem gives the first-order condition:

$$\frac{\partial ln\Lambda}{\partial lnw^i} = \lambda \frac{\mu^i \omega_E^i}{\left(\omega_E^i - rV_U\right)} - (1-\lambda)\frac{\omega_F^i}{y - \omega_F^i} = 0, \tag{7}$$

where

$$\mu^i \equiv \frac{\partial ln\omega_E^i}{\partial lnw^i} = \frac{1 - T_E^{'}(w^i)}{1 - T_E/w^i}$$

is the elasticity of the individual's after-tax real wage with respect to the before-tax real wage. μ^i, sometimes denoted the *coefficient of residual income progression*, is a measure of income tax progressivity. If $\mu^i < 1$, a one per cent increase in the before-tax real wage w^i causes a less than one per cent increase in the after-tax real wage ω_E^i, indicating that the income tax is progressive. This occurs when the marginal tax rate $T_E^{'}$ is higher than the average tax rate T_E/w^i. The lower the elasticity μ^i, the more progressive is the income tax.

Using (1) and (2) to solve for rV_U, we obtain:

$$rV_U = \left[\frac{r+q}{r+q+s(\theta)}\right] b + \left[\frac{s(\theta)}{r+q+s(\theta)}\right]\omega_E,$$

where ω_E is the after-tax wage that the worker would obtain in another firm. Substituting this expression into (7) yields:

$$\lambda \frac{\mu^i}{\left(1 - \left(\frac{r+q}{r+q+s(\theta)}\right)\rho^i - \left(\frac{s(\theta)}{r+q+s(\theta)}\right)\omega_E/\omega_E^i\right)} = (1-\lambda)\frac{\omega_F^i}{y - \omega_F^i}, \tag{8}$$

where $\rho^i = b/\omega_E^i$ is the after-tax replacement rate of individual i. Because $\omega_E^i = w^i - T_E(w^i)$, $\omega_E = w - T_E(w)$ and $\omega_F^i = (1+\tau)w^i$, the condition (8) implicitly defines a real wage equation for an individual worker:

$$w^i = w^i\left(\rho^i, \mu^i, \tau, \theta, y, w; r, q, \lambda\right). \tag{9}$$

Here w is the worker's outside option in terms of the before-tax wage that would be obtained in another firm. The individual's real wage thus depends on the net replacement rate ρ^i (which reflects both the before-tax replacement rate and EITCs), income tax progressivity μ^i, the payroll tax rate τ, labour market tightness θ, labour productivity

y and the outside wage w as well as on the real interest rate r, the separation rate q and the bargaining power of workers λ.

Differentiating (8), we find that:

$$\frac{\partial w^i}{\partial \rho^i} = \frac{(1-\lambda)(r+q)(w^i/\mu^i)}{\phi} > 0,$$
$$\frac{\partial w^i}{\partial \mu^i} = \frac{\lambda(r+q+s(\theta))\left(y/\omega_F^i - 1\right)(w^i/\mu^i)}{\phi} > 0,$$
$$\frac{\partial w^i}{\partial \tau} = -\frac{\lambda(r+q+s(\theta))\left(y/(1+\tau)^2\right)}{\phi} < 0,$$
$$\frac{\partial w^i}{\partial \theta} = \frac{\left(\omega_E/\omega_E^i - \rho^i\right)(1-\lambda)s'(\theta)(r+q)/(r+q+s(\theta))(w^i/\mu^i)}{\phi} \lesseqgtr 0,$$
$$\frac{\partial w^i}{\partial y} = \frac{\lambda(r+q+s(\theta))/(1+\tau)}{\phi} > 0,$$
$$\frac{\partial w^i}{\partial w} = \frac{(1-\lambda)s(\theta)\left(1-T_E'(w)\right)\left(\mu w^i \omega_E/\mu^i w \omega_E^i\right)}{\phi} > 0,$$

where

$$\phi = (1-\lambda)s(\theta)\left(\omega_E/\omega_E^i\right) + \lambda(r+q+s(\theta))\left(y/\omega_F^i\right) > 0.$$

An increase in the individual's net replacement rate ρ^i raises the real wage because it gives the worker a better outside option (higher income if there is no agreement with the employer and the worker stays unemployed). An increase in the before-tax replacement rate affects the real wage in a similar way as an EITC as both increase the net replacement rate. A decrease in income tax progressivity, i.e., an increase in the progressivity variable μ^i, also raises the wage, as it gives the worker a higher payoff from a before-tax real wage increase in terms of the after-tax real wage. An increase in the payroll tax rate τ reduces the real wage because it decreases the surplus that workers and employers share. An increase in labour market tightness θ has an ambiguous effect but raises the real wage if $\omega_E/\omega_E^i > \rho^i$. The interpretation is that the worker's outside option is improved the faster a job can be found in another firm, provided that the after-tax wage there is higher than the after-tax unemployment benefit. An increase in labour productivity y raises the real wage because the surplus to be shared between workers and employers increases. Finally, an increase in the outside wage w also increases the individual's wage, as it improves the outside opportunity.

In a symmetric equilibrium, with identical wages across firms, the expressions are simplified. Imposing $w^i = w$ on (9) gives the equilibrium real wage as:

$$w = \frac{1}{(1+\tau)} \frac{\lambda\mu(r+q+s(\theta))y}{[(1-\lambda)(1-\rho)(r+q) + \lambda\mu(r+q+s(\theta))]}. \tag{10}$$

Equation (10) now determines an aggregate equilibrium before-tax real wage, which can be written in the general form:

$$w = w(\rho, \mu, \tau, \theta, y; r, q, \lambda). \tag{11}$$

It is straightforward to show that the signs of the partial derivatives of equation (11) are the same as those of equation (9). The only exception is $\partial w/\partial \theta$, which is now unambiguously positive, such that an increase in labour market tightness raises the equilibrium real wage. This follows immediately from the earlier expression for $\partial w^i/\partial\theta$ as symmetry implies $\omega_E/\omega_E^i = 1$, which gives $\left(\omega_E/\omega_E^i\right) - \rho^i = 1 - \rho > 0$.

4 Empirical strategy

Our main focus is on estimating regressions corresponding to equation (9), which explains individual real wages. The equations are estimated in first differences rather than in levels. This has several advantages. Measurement errors that are constant over time are removed. Potential non-stationarities in the data and problems that may arise due to autocorrelation are also taken care of. By estimating fixed-effects models, we can also allow for differing individual wage trends.

In the presence of labour market rigidities, it is likely that wage adjustments to labour market reform may take time to occur. Ideally we would therefore like to allow for a rich lag structure in the wage equations, but the short sample period (2004-2009) makes a more dynamic specification unfeasible.[5]

Since we choose to use the change in the *nominal* hourly wage as the dependent variable, inflation Δlnp_t has to be added as an explanatory variable. The other main explanatory variables are the changes in the net replacement rate, the measure of tax progressivity, the payroll tax rate and the labour market situation.

According to equation (9), the outside wage (the wage that the individual worker would receive in another firm) and individual productivity should also enter as arguments. It is not obvious how to treat these variables in our data. However, the worker's outside option is likely to be a function of individual characteristics. It is reasonable to assume that the individual's profession, experience and other traits are proxies for his opportunities outside the workplace. We therefore add a range of individual controls that are known to affect individual wages to the equation, specifically educational level and type, previous unemployment, region of birth, age, gender and civil status. This amounts to an assumption that such individual characteristics determine different trends in the outside wage and that individuals base their expectations of it on these trends. The individual characteristics can also be thought of as capturing trends in individuals' productivity. Admittedly, these are crude ways of capturing changes in the outside wage and productivity since they do not allow for variations across years. We do, however, include fixed time effects in some specifications. The remaining variables in equation (9), i.e., the real interest rate, the job destruction rate and the bargaining strength parameter, are treated as fixed.

Our benchmark regression equation is thus:

$$\Delta lnw_{it} = \beta_0 + \beta_1 \Delta lnp_t + \beta_2 \Delta\rho_{it} + \beta_3 \Delta\mu_{it} + \beta_4 \Delta\tau_{it} + \beta_5 \Delta\theta_{it} \quad + \sum\nolimits_j \beta_{5+j} x_{ijt} + \epsilon_{it}, \tag{13}$$

where w from now on denotes the nominal hourly wage, and the $x_j:s$ denote the individual control variables. Subscript i denotes the individual and subscript t the time period.

To account for the evolution of the business cycle during the sample period, we proceed as follows. First, the wage equation (9) suggests that labour market tightness should enter as an explanatory variable, and in the empirical specification we let the change in unemployment in the municipality of residence proxy for changes in the individual's labour market.[6] Second, to control for business-cycle effects at the aggregate level, we report results both with and without year dummies throughout the analysis.[7] As the changes in the payroll tax during the sample period were related to the individual's age (see Section 2), they are proxied by the following dummy variables:

$$D_{1it} = \begin{cases} 1 \; if \; a_{it} < 25 \, for \; t = 2007 \\ 0 \; othwerwise \end{cases}$$

$$D_{2it} = \begin{cases} 1 \; if \; \; a_{it} < 26 \, for \; t = 2009, \\ 0 \; othwerwise \end{cases}$$

where a_{it} denotes the individual's age.

A key challenge is how to deal with the fact that the net replacement rate ρ^i and the tax progressivity variable μ^i for the individual are functions of income (and thus the wage rate) and therefore endogenous. This is so because tax rates vary with income and because there has been a fixed nominal floor and a fixed nominal ceiling for the before-tax unemployment benefit (see Section 2). Moreover, the individual's net replacement rate is not directly observable since the wage data apply to employed persons. We therefore must predict the net replacement rate that the individual would obtain in the event of unemployment. To address these issues, we compute the net replacement rate and the tax progressivity variable at the individual level based on various *exogenised* measures of income. We try different ways in order to check the robustness of our results as explained below.

4.1 Benchmark specification

Our first approach is to base the replacement rate and the tax progressivity variable on the individual's lagged wage, corrected for average wage growth. This gives us a series of predicted wages according to:

$$\widetilde{w}_{it} = \left(1 + \gamma_t\right) w_{it-1}, \tag{14}$$

where $\tilde{w}_{it}$ is the predicted nominal wage of individual i at time t, and γ_t is average wage growth from period $t - 1$ to t, i.e., $\gamma_t = N^{-1} \sum_i (w_{it} - w_{it-1}) / w_{it-1}$ with N being the number of individuals. In a similar fashion we use hours worked in the previous period as a predictor for actual working time.

The changes in the net replacement rate and the tax progressivity variable in wage equation (13) are computed with the help of the following equations:

$$\rho_{it} = \frac{b_{it}\left(\widetilde{w}_{it} l_{t-1}, u^e_{it}\right) - T_U(b_{it})}{\widetilde{w}_{it} l_{t-1} - T_E\left(\widetilde{w}_{it} l_{t-1}\right)} \tag{15}$$

$$\mu_{it} = \frac{1 - T'_E(\tilde{w}_{it} l_{t-1})}{1 - T_E(\tilde{w}_{it} l_{t-1}) / \tilde{w}_{it} l_{t-1}}, \tag{16}$$

where b_{it} now denotes the nominal unemployment benefit of worker i at time t, u^e_{it} denotes the expected unemployment duration of the worker, and T_U and T_E denote nominal taxes on unemployment benefits and income from work, respectively. Equation (13) is then estimated by OLS.

4.2 Reform variables based on Mincer wages

While using lagged income as a proxy for actual income is appealing in its simplicity, we also estimate Mincer-type equations and use the wage predictions from these estimations to compute the net replacement rate and the progressivity variable as a robustness check. The advantage is that the Mincer equations can be estimated on pre-reform data, which purges the predicted income measures of any effects of the reforms. Specifically, we estimate:

$$lnw_{it}^{M} = \varphi_0 + \sum\nolimits_j \varphi_j z_{ijt} + \lambda_t + \epsilon_{it} \tag{17}$$

for $t < 2007$, where the z_j:s are independent variables comprising educational level and type, gender, age, civil status and a dummy indicating whether or not the individual is foreign born. λ_t is a fixed time effect. To obtain more accurate predictions after 2006, we adjust the obtained series of predicted wages for aggregate wage growth for $t \geq 2007$ and thus compute:

$$\hat{W}_{it}^{M} = \begin{cases} exp\left(\hat{\varphi}_0 + \sum\nolimits_j \hat{\varphi}_j z_{ijt} + \hat{\lambda}_t\right) for\ t < 2007 \\ \hat{w}_{i06}^{M} \prod\nolimits_{k=0}^{l} \left(1 + \bar{\gamma}_{t+k}\right) for\ t = 2007 + l,\ l = 0, 1, 2, \end{cases} \tag{18}$$

where $\bar{\gamma}_t$ is aggregate wage growth from period $t - 1$ to t.[8] Having computed the net replacement rate and the progressivity variable from this exogenised measure of income, we estimate (13) by OLS.

4.3 An instrumental variables approach

An alternative to estimating (13) by OLS is to use changes in the net replacement rate and in the progressivity variable based on the Mincer predictions as instruments for $\Delta\rho_{it}$ and $\Delta\mu_{it}$ in 2SLS estimations.

In the first stage we estimate:

$$\Delta\rho_{it} = \chi_0 + \chi_1 \Delta\rho_{it}^{M} + \sum\nolimits_j \chi_{1+j} x_{ijt} + \epsilon_{it}^{1}, \tag{19}$$

$$\Delta\mu_{it} = \psi_0 + \psi_1 \Delta\mu_{it}^{M} + \sum\nolimits_j \psi_{1+j} x_{ijt} + \epsilon_{it}^{2}, \tag{20}$$

where $\Delta\rho_{it}^{M} = \rho_{it}\left(\hat{w}_{it}^{M}\right) - \rho_{it-1}\left(\hat{w}_{it-1}^{M}\right)$ and $\Delta\mu_{it}^{M} = \mu_{it}\left(\hat{w}_{it}^{M}\right) - \mu_{it-1}\left(\hat{w}_{it-1}^{M}\right)$. In the second stage, the predicted $\Delta\rho_{it}$ and $\Delta\mu_{it}$ from (20) and (21) are used when estimating (13).

4.4 Wage equations at the group level

Consistent with the aggregate wage equation (11), we complement the wage equations at the individual level by regressions on group averages. This is a crude way of addressing the theoretical concern that, for example, a change in the net replacement rate may have spillover effects across individuals in a particular labour market, i.e., that the individual's wage is not only affected by a change in the own replacement rate but also by changes in other workers' replacement rates via the effects on their wages and thus on the individual's outside option. More precisely, we divide the individuals into percentiles based on the distribution implied by the Mincer predictions in 2006. The percentiles are then viewed as separate labour markets for workers with different skill levels and the average wage in the percentile as a proxy for the equilibrium wage in that market. The reason we condition on the 2006 distribution is that we want to purge the replacement rate and the progressivity variable of wage effects induced by changes in these variables.

We thus compute the average actual wage, the average net replacement rate and the average of the progressivity variable in each percentile as follows:

$$\bar{w}_{kt} = {n_{kt}}^{-1} \sum\nolimits_{i \in k} w_{it},$$

$$\bar{\rho}_{kt} = {n_{kt}}^{-1} \sum\nolimits_{i \in k} \rho_{it}\left(\hat{w}_{it}^{M}\right)$$

$$\bar{\mu}_{kt} = {n_{kt}}^{-1} \sum\nolimits_{i \in k} \mu_{it}\left(\hat{w}_{it}^{M}\right),$$

where k denotes the percentile, and n_{kt} denotes group size. We estimate the following model:

$$\Delta \ln \bar{w}_{kt} = \alpha_k + \eta_1 \Delta \bar{\rho}_{kt} + \eta_2 \Delta \bar{\mu}_{kt} + \lambda_t + \epsilon_{kt}, \quad (21)$$

where α_k is a group-specific fixed effect which, given that we are estimating first differences, is equivalent to including a group-specific trend. To account for the fact that group size may vary over time, we weigh the estimations by average group size.

The aggregation comes at a cost, however. Since aggregating the data reduces the number of observations substantially, the precision of the estimates decreases.

5 Data

We use data from the LINDA database, including register data and survey-based information on wages. The database contains a large sample of individuals 18-64 years of age. We select individuals who were employed at least once during the period 2004-2009 and follow them over time. The database also holds detailed information on age, gender, working time as a share of full-time employment, civil status, educational level and type, place of birth and earlier unemployment.

Membership in the unemployment insurance funds described in Section 2 is approximately 75 per cent of employment (Akademikernas a-kassa 2012). We compute the net replacement rate as the one that each worker would obtain as a member of an unemployment insurance fund. There exist data neither on whether individuals are actually members in such funds nor on whether they have any supplementary unemployment insurance.[9] Such supplementary insurance is often provided by trade unions and sometimes in collective agreements.

We are thus estimating the statistical relationship between the wage and the net replacement rate that employed workers would get if they are members in an unemployment insurance fund and receive no supplementary benefits. This can be viewed in two ways. One is to regard the computed net replacement rate as the one which workers *perceive* and which therefore influences wage setting. Such an interpretation receives support from the strong focus in the public discussion on benefit levels in the unemployment insurance provided by the funds and evidence on low awareness among employees of supplementary benefits.[10] The alternative interpretation is that we have a measurement error in our replacement-rate variable. The change in the actual net replacement rate may be both lower and higher than our proxy. If the measurement error is randomly distributed, there is an attenuation bias in our estimates so that we will underestimate the true effects of the replacement rate on wages.[11]

When computing net replacement rates, we approximate expected unemployment duration by the pre-2007 distribution of length of unemployment spells. Average unemployment duration is computed for each wage decile, and the estimates are subsequently applied to each individual in that part of the distribution.

Descriptive statistics for key variables are given in Table 1. The table shows that the wage is increasing over time and that there is substantial wage dispersion in the sample. Wages grow at an annual rate in the range of 3.7-5.8 per cent, peaking in 2008.

The net replacement rate, based on predicted wages according to (14), is decreasing over time, with the largest decrease occurring between 2006 and 2007, when the first step of the EITC was introduced at the same time as unemployment benefits were lowered.[12] The mean net replacement rate was over 70 per cent in 2005 but decreases by more than 10 percentage points until 2009.

The progressivity variable, also based on wage predictions, is falling over the period 2005-2008, reflecting an increase in progressivity induced by lower average taxes. Progressivity does, however, decrease slightly between 2008 and 2009 when the threshold for paying the state income tax was raised.

The average local unemployment rate fell from 5.9 per cent in 2005 to 3.7 per cent in 2008 but then increased again to 5.9 per cent in 2009. Mean working time, as a share of full-time employment, is stable slightly below 90 per cent, but there is large dispersion in the sample. The average individual is 42 years of age, and the sample is comprised of equal shares of men and women.

6 Results

Table 2 displays the results from estimating the benchmark version of equation (13), in which the replacement rate and the progressivity variable are based on the individual's lagged wage corrected for aggregate wage growth.[13] We start by running simple regressions of the difference in the log wage on the first differences in the net replacement rate and the progressivity measure and then gradually add more variables. All columns exploit the full sample except columns (8) and (9), which exclude entrepreneurs and part-time employed, respectively. In columns (10) and (11), year dummies are included and in column 12, individual fixed effects.

In all the regressions there is a significant, positive relation between the change in the net replacement rate and wage growth as hypothesised, with most estimated semi-elasticities in the range of 0.33-0.40. A reduction in income tax progressivity (an increase in the variable) also has a significantly positive effect on wage growth, although this effect is much smaller than for the net replacement rate (a semi-elasticity around 0.04).[14] When the dummies for payroll tax reductions are included in columns (7) and (11), they are insignificant.

The change in the municipality unemployment rate has a small, but significant, negative impact on wage growth in all but one of the equations where it is included. Inflation is

Table 1 Descriptive statistics, 2005-2009

	Year	2005	2006	2007	2008	2009
Monthly wage	Mean	24 205	25 115	25 795	27 115	27 991
	St Dev	11 591	12 171	12 229	12 527	12 590
	Min	10 000	12 000	12 000	12 000	12 000
	Max	1 043 707	1 232 252	960 882	736 626	668 145
Wage growth	Mean	.037	.044	.041	.058	.037
	St Dev	.117	.120	.125	.124	.119
	Min	-2.141	-2.086	-1.940	-2.004	-2.196
	Max	2.340	2.477	1.754	2.014	2.310
Net replacement rate	Mean	.710	.697	.630	.603	.582
	St Dev	.129	.133	.131	.132	.133
	Min	.032	.023	.019	.024	.031
	Max	.860	.859	.795	.795	.795
Net replacement rate growth	Mean		-.016	-.072	-.032	-.023
	St Dev		.051	.056	.056	.056
	Min		-.571	-.654	-.567	-.575
	Max		.614	.434	.505	.579
Progressivity variable	Mean	.871	.868	.858	.851	.864
	St Dev	.090	.088	.097	.100	.092
	Min	.672	.666	.647	.641	.637
	Max	1	1	1	1	1
Change in progressivity variable	Mean		-.004	-.012	-.009	.012
	St Dev		.067	.068	.073	.080
	Min		-.314	-.338	-.354	-.350
	Max		.319	.326	.339	.346
Local unemployment	Mean	.059	.053	.039	.037	.059
	St Dev	.016	.015	.012	.012	.018
	Min	.023	.021	.013	.009	.018
	Max	.141	.115	.089	.094	.138
Hours worked	Mean	.896	.898	.898	.897	.897
	St Dev	.215	.215	.214	.217	.216
	Min	.010	.006	.010	.004	.010
	Max	1.000	1.000	1.000	1.000	1.000
Age	Mean	42.073	42.000	41.926	41.936	42.211
Male	Mean	.500	.506	.501	.503	.498
Max observations		119 438	119 236	124 426	122 977	119 296

Note: The net replacement rate and the progressivity variable are based on wage predictions according to equation (14). Local unemployment is calculated as the unemployment-to-population ratio. Both openly unemployed and participants in labour market programmes are counted as unemployed.

positively correlated with nominal wage growth, with a coefficient somewhat below unity. Age is negatively correlated with wage growth, suggesting that younger workers face steeper earnings profiles than older workers.

In Table 3, the net replacement rate and the progressivity variable are based on Mincer wage predictions. The point estimates of the wage semi-elasticity with respect to the net replacement rate are in all cases except one lower than in the benchmark

Table 2 Estimated wage equations when the replacement rate and progressivity variable are based on lagged wages

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Inflation				.766***	.725***	.724***	.726***	.740***	.647***			.514***
				(.014)	(.018)	(.018)	(.018)	(.018)	(.020)			(.021)
Change in replacement rate	.343***		.332***	.367***	.369***	.368***	.369***	.365***	.490***	.395***	.395***	.547***
	(.006)		(.006)	(.006)	(.006)	(.006)	(.006)	(.006)	(.008)	(.007)	(.007)	(.004)
Change in progressivity variable		.111***	.028***	.040***	.040***	.040***	.040***	.040***	.039***	.034***	.034***	.040***
		(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
Change in unemployment rate					-.057***	-.058***	-.054***	-.036**	-.319***	-.121***	-.121***	-.007
					(.017)	(.017)	(.017)	(.017)	(.019)	(.033)	(.033)	(.000)
Dummy for earlier unemployment					-.001***	-.001	-.001	-.001	.006***	-.001	-.001	.001
					(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.000)	(.001)
Male				-.018	-.020	-.027	-.027	.009	-.498***	-.019	-.019	
				(.045)	(.045)	(.045)	(.045)	(.045)	(.049)	(.045)	(.045)	
Age				-.089***	-.089***	-.226***	-.217***	-.231***	-.363***	-.224***	-.236***	-.005***
				(.002)	(.002)	(.015)	(.016)	(.015)	(.017)	(.015)	(.016)	(.001)
Age squared						.157***	.148***	.163***	.282***	.153***	.165***	.000***
						(.017)	(.018)	(.016)	(.018)	(.017)	(.018)	(.000)
Payroll dummy 2007							.004				-.002	
							(.003)				(.002)	
Payroll dummy 2009							.000				-.003	
							(.002)				(.002)	
Controls				Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Entrepreneurs excluded								Yes				
Full-time employed									Yes			
Year dummies										Yes	Yes	
Individual fixed effects												Yes
N	382 548	382 548	382 548	382545	382 545	382 545	382 545	374 786	291 656	382 545	382 545	382 545
R2	.031	.005	.031	.048	.048	.049	.049	.049	.078	.050	.050	.084

Note: Dependent variable: first difference of log nominal wage. Sample period: 2006-2009. Where indicated, the controls comprise educational level and type, region of birth and civil status. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. The coefficients and standard errors for Male and Age have been multiplied by 100, and the coefficient and standard errors for Age squared by 100^2.

Table 3 Estimated wage equations when the replacement rate and progressivity variable are based on estimated Mincer wages

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Inflation				.660***	.688***	.685***	.687***	.707***	.595***			
				(.015)	(.019)	(.019)	(.019)	(.019)	(.021)			
Change in replacement rate	.083***		.086***	.220***	.210***	.203***	.203***	.201***	.161***	.324***	.328***	.641***
	(.008)		(.008)	(.009)	(.010)	(.010)	(.010)	(.010)	(.011)	(.022)	(.022)	(.024)
Change in progressivity variable		-.015***	-.017***	.010***	.009***	.008***	.008***	.008***	.008***	.004	.004	.006*
		(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
Change in unemployment rate					.051***	.055***	.052***	.077***	-.076***	-.124***	-.124***	-.040
					(.018)	(.018)	(.018)	(.018)	(.020)	(.034)	(.034)	(.039)
Dummy for earlier unemployment					.004***	.004***	.004***	.004***	.008***	.004***	.004***	.007***
					(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Male				-.054	-.039	-.045	-.044	-.014	-.237***	-.047	-.047	
				(.046)	(.046)	(.046)	(.046)	(.046)	(.050)	(.046)	(.046)	
Age				-.090***	-.088***	-.263***	-.259***	-.266***	-.388***	-.253***	-.259***	-.994***
				(.002)	(.002)	(.014)	(.016)	(.014)	(.017)	(.015)	(.016)	(.092)
Age squared						.204***	.199***	.208***	.325***	.189***	.195***	.897***
						(.016)	(.017)	(.016)	(.018)	(.016)	(.017)	(.091)
Payroll dummy 2007							-.000				-.003	
							(.003)				(.003)	
Payroll dummy 2009							.002				.001	
							(.002)				(.002)	
Controls				Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Entrepreneurs excluded								Yes				
Full-time employed									Yes			
Year dummies										Yes	Yes	
Individual fixed effects												Yes
N	427 959	427 959	427 959	427 956	427 956	427 956	427 956	418 773	320 026	427 956	427 956	427 956
R2	.000	.000	.000	.014	.014	.014	.014	.015	.020	.015	.015	.010

Note: Dependent variable: first difference of log nominal wage. Sample period: 2006-2009. Where indicated, the controls comprise educational level and type, region of birth and civil status. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. The coefficients and standard errors for Male and Age have been multiplied by 100, and the coefficient and standard errors for Age squared by 100^2.

equations: when controls are included the estimates are in the range of 0.16–0.32. The effects of progressivity on the wage are of the same order of magnitude as before. Again, we find no significant effects of the payroll tax dummies. In these regressions, previous unemployment is positively related to wage growth, although the effect is very small, whereas the (very small) effect of municipal unemployment is unstable.

The results from using the replacement rate and the progressivity measure based on Mincer wages as instruments for the actual variables are displayed in Table 4. This yields estimates for the effect of the net replacement rate that are very similar to those obtained by the OLS-estimations in Table 3.[15] But here the point estimates for the progressivity variable are much larger than before: with controls included they are in the interval 0.44–0.54. The 2009 payroll tax dummy is now significantly positive (indicating a wage-raising effect of the reduction for young people). The impact of municipal

Table 4 Estimated wage equations when the replacement rate and progressivity variable are instrumented by reform variables based on estimated Mincer wages

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Inflation				.843***	.745***	.736***	.743***	.761***	.675***
				(.048)	(.031)	(.031)	(.032)	(.031)	(.042)
Change in replacement rate	.107***		.201***	.215***	.246***	.241***	.241***	.239***	.181***
	(.010)		(.020)	(.024)	(.019)	(.019)	(.019)	(.019)	(.019)
Change in progressivity variable		-.330***	-.401***	.442***	.540***	.485***	.504***	.494***	.429***
		(.064)	(.074)	(.126)	(.155)	(.155)	(.161)	(.160)	(.155)
Change in unemployment rate					-.214***	-.189***	-.204***	-.165***	-.301***
					(.059)	(.059)	(.064)	(.060)	(.064)
Dummy for earlier unemployment					.003***	.003***	.003***	.003***	.007***
					(.001)	(.001)	(.001)	(.001)	(.001)
Male				.044	.073	.061	.064	.095*	-.160***
				(.051)	(.053)	(.052)	(.053)	(.052)	(.059)
Age				-.096***	-.096***	-.247***	-.235***	-.249***	-.385***
				(.002)	(.002)	(.015)	(.017)	(.015)	(.017)
Age squared						.176***	.164***	.180***	.311***
						(.018)	(.020)	(.018)	(.021)
Payroll dummy 2007							-.001		
							(.002)		
Payroll dummy 2009							.004**		
							(.002)		
Controls				Yes	Yes	Yes	Yes	Yes	Yes
Entrepreneurs excluded								Yes	
Full-time employed									Yes
N	426 819	426 819	426 819	426 816	426 816	426 816	426 816	417 633	319 510

Note: Dependent variable: first difference of log nominal wage. Sample period: 2006-2009. IV estimations (2SLS). Where indicated, the controls comprise educational level and type, region of birth and civil status. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. The coefficients and standard errors for Male and Age have been multiplied by 100, and the coefficient and standard errors for Age squared by 100^2.

unemployment is significantly negative. Previous unemployment is still positively associated with wage growth, although the effect remains very small.

Table 5 shows the estimations with percentile groups as the unit of observation. As shown in columns (1)-(4), the relation between the average net replacement rate and the mean wage is significant and positive. The estimated magnitude is of the same order as in Tables 3 and 4 and obtains regardless of whether we include group fixed effects and weights capturing group size. The progressivity variable, however, becomes insignificant in these percentile equations. Columns (5) and (6) show that when adding time dummies, also the net replacement rate becomes insignificant. This is not surprising as much of the variation in the data is already removed when aggregating the observations into percentiles and adding year dummies further consumes some of the remaining variation. We interpret the findings from the group estimations as broadly consistent with our results from the analysis of individual wages.

Overall, our estimates imply semi-elasticities between an individual's wage and the net replacement rate of the order of magnitude of 0.2-0.4. How should one interpret these magnitudes and how do they relate to the results in other studies referred to in Section 1? Writing in terms of differentials instead of differences as above, we have estimated the semi-elasticity $dlnw^i/d\rho^i = \beta_2$, where $\rho^i = b/\omega_E^i$ and $\omega_E^i = w^i - T_E(w^i)$. The elasticity of the wage with respect to the unemployment benefit is $dlnw^i/dlnb = \beta_2\rho^i/(1+\beta_2\rho^i)$. Setting $\rho^i = 0.65$ (see Table 1), it follows that our estimates of the semi-elasticity β_2 implies a wage elasticity with respect to the benefit level in the range 0.12-0.21. This is close to, but somewhat larger, than most of the estimates of the elasticity of the reservation wage with respect to the unemployment benefit level reported in Section 1.

We can also compute what our estimated semi-elasticities imply for the incidence of the EITC. To simplify, we make the calculation assuming that the income tax on wage income is proportional, i.e., that $\omega_E^i = (1-t)w^i$, where t is the tax rate, and $(1-t)$ is the net-of-tax rate. Then it is straightforward to show that the elasticity of the wage with respect to the net-of tax rate is equal to minus the elasticity of the wage with respect to the unemployment benefit, i.e., $dlnw^i/dln(1-t) = -\beta_2\rho^i/(1+\beta_2\rho^i)$. The elasticity of the after-tax wage with respect to the net-of-tax rate is $dln\omega_E^i/dln(1-t) = 1-[\beta_2\rho^i/(1+\beta_2\rho^i)]$. It

Table 5 Estimated wage equations at the percentile income group level

	(1)	(2)	(3)	(4)	(5)	(6)
Change in mean replacement rate	.200***	.200***	.199***	.199***	-.086	-.078
	(.046)	(.046)	(.046)	(.046)	(.182)	(.182)
Change in mean of progressivity variable		.001		.000		.019
		(.017)		(.017)		(.016)
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Weights			Yes	Yes	Yes	Yes
Year dummies					Yes	Yes
N	400	400	400	400	400	400
R2	.060	.060	.060	.060	.255	.258

Note: Dependent variable: first difference of log nominal wage. Sample period: 2006-2009. Mean wages and reform variables are computed over percentile income intervals based on the 2006 income distribution implied by predicted Mincer wages. The constant is not reported. Robust standard errors are reported within parenthesis. ***: significant at the 1 per cent level; **: significant at the 5 per cent level; *: significant at the 10 per cent level. Weights indicate average group size.

follows that a one per cent increase in the net-of-tax rate is associated with a fall of 0.12-0.21 per cent in the before-tax wage and an increase of 0.79-0.88 per cent in the after-tax wage. The shifting of the EITC onto employers through lower wages, according to our study, is thus somewhat smaller than according to the studies for the US and the UK referred to in Section 1.

7 Conclusions

There exists a large empirical literature on the effects of unemployment benefits and earned income tax credits (EITCs) on unemployment and employment. But the mechanisms through which these variables are affected have been much less studied. Wage formation is likely to be a very important channel. We set up a theoretical model where both unemployment benefits and EITCs influence wages through their effects on the net (after-tax) replacement rate for the unemployed. The model is used to explain wages in Sweden in 2006-09, when an EITC was introduced in several steps and benefit generosity reduced, employing a large micro data set for individuals.

A key challenge is how to handle the reverse-causality problem that the net replacement rate is an endogenous variable: since it is not only the case that the wage depends on the net replacement rate, the unemployment benefit and tax rules it also implies that the net replacement rate depends on wage income. We address this problem by trying to exogenise the replacement rate in various ways: by computing measures based on lagged wages corrected for aggregate wage growth, by predicting wages through Mincer equations and by instrumentation.

When estimating wage equations for individuals, we find strong, significant wage effects from variations in the net replacement rate. The estimated semi-elasticities are mostly in the interval 0.2-0.4. This implies absolute values of the elasticities of the wage with respect to the unemployment benefit level and to the net-of-tax rate of 0.1-0.2. Aggregating individuals into percentiles of the wage distribution gives less stark results but also suggests a positive correlation between the net replacement rate and wages. Our findings thus support the hypothesis that the recent introduction of an EITC and reduction in unemployment benefit levels in Sweden were conducive to wage moderation.

One should, however, interpret our results with some caution. Strictly speaking, we have found a statistically significant relationship between the wage for an individual and the net replacement rate that this individual would get from being a member of an unemployment insurance fund in the absence of supplementary benefits provided by unions or in collective agreements. We have argued that this is a good proxy for the perceived net replacement rate.

It should also be noted that the estimates from our wage equations for individuals do not take account of spillover effects on other wages because wage reductions in one firm deteriorate the outside option for workers in other firms. Hence, our estimates are best regarded as relative-wage effects. The general-equilibrium effects on the aggregate wage are likely to be larger than in our estimates: a general reduction in the net replacement rate will for each worker have both a *direct* effect (from the change in the own replacement rate) and an *indirect* effect (from the wage decrease for other workers induced by the reduction in their replacement rates) reinforcing the direct effect.

There are interesting extensions to our analysis that should be considered. First, it would be desirable to measure the actual replacement rates better by taking account of supplementary benefits provided by unions or in collective agreements. Data on such insurance do not exist, but proxies might be constructed by attributing union membership to individuals from information on sector of employment and education. Second, it would be interesting to include direct measures of the outside wage rather than controlling for individual characteristics. Ideally, we would like to gauge the spillover effects on individual wages from the impact of changes in the net replacement rate for other workers in the same labour market in order to analyze the general-equilibrium effects. Third, as more data become available over time, assessing the long-term effects by estimating models with richer dynamics would shed additional light on the workings of the reforms. Fourth, one should be aware that no legislated mimimum wages exist in Sweden. An interesting extension would be to compare the responsiveness of wages to the EITC and unemployment benefits in Sweden with the responsiveness in countries with such mimimum wage legislation.

EITCs and reductions in unemployment benefits are widely used policy tools in the fight against unemployment. Consistent with theoretical predictions, our results suggest that such reforms strengthen incentives for wage restraint, which is likely to be employment-promoting.

Endnotes

[1]One of the few exceptions is Forslund et al. (2008) who use the Nordic countries as a panel.

[2]The Swedish unemployment insurance and the recent changes in it are described in detail in Swedish Fiscal Policy Council (2008; 2011).

[3]See Edmark et al. (2012) for a detailed description of the tax credit and the extensions made in 2008 and 2009.

[4]See pp 751-764.

[5]Most collective wage agreements during the period have been for two or three years. However, the collective agreements, which are concluded at the industry level, mainly concern average wage increases in firms. The distribution of wage increases between individuals are negotiated each year at the level of the firm, very often without any guaranteed wage increases for individuals. In some collective agreements, no numbers for wage increases are specified at all; instead, wage increases are determined in annual bargaining between individual union members and the employer. The wage-setting arrangements described could motivate a fairly quick response of *individual* wages to various changes in the economic environment.

[6]Because there are no data on vacancies per municipality, labour market tightness cannot be computed.

[7]Our estimations cover the onset of the international financial crisis in 2008/2009. It is, of course, possible that the specific conditions prevailing then could have affected the responsiveness of wages to our various explanatory variables. This problem is difficult to address with the few years we have in our data set, but it should be kept in mind.

[8]In the benchmark wage equations in Section 4.1, we instead used average wage growth. This measure refers to the average wage growth between two years for those

individuals who were employed in two consecutive years and thus includes individual career effects. Aggregate wage growth refers instead to the growth in the average wage of the entire sample between two years. Comparing actual wages to the Mincer predictions reveals that aggregate wage growth gives more accurate forecasts over the wage distribution than average wage growth. Another difference compared to the benchmark equations is that instead of using hours worked in the preceding year as a proxy for actual hours, we here assume full-time employment. The advantage of assuming full-time employment is that we can include also individuals who are temporarily out of work in the estimations. The disadvantage is that we may generate measurement errors in the exogenised income measure to the extent that the part-time employed are misrepresented.

[9]In principle, one could include other sources of insurance in the replacement rate, such as income within the household, to capture informal insurance within families. However, since our focus is on the effects of the labour market reforms, we want to purge the net replacement rate from such influence.

[10]According to a survey commissioned by the Swedish Fiscal Policy Council (2010), only 4 per cent of the unemployed stated that they received supplementary benefits, although 20 per cent of the unemployed were entitled to such benefits provided by unions.

[11]To the extent that the measurement error is correlated with the true net replacement rate, the bias may be larger or smaller than the attenuation bias with randomly distributed errors. This depends on the sign of the correlation and the relative magnitudes of the variances of the measurement error and the actual replacement rate (See e.g. Pischke 2007). Not much can be said about possible correlations and relative variances in our data.

[12]Descriptive statistics for the net replacement rate and the progressivity variable based on actual wages are displayed in Bennmarker et al. (2011). It is shown that the measures based on wage predictions have a high degree of accuracy.

[13]Our data comprise the period 2004-09, but since two years are spent predicting wages on lagged values and then taking first differences, our estimations cover the period 2006-09. Throughout the analysis, we report robust standard errors, but the main effects remain significant also when standard errors are clustered at the municipal level.

[14]The result that lower progressivity is positively correlated with wage growth is consistent with the results in, for example, Lockwood and Manning (1993), Holmlund and Kolm (1995) and Hansen et al. (2000).

[15]It should be noted that if the instrument is uncorrelated with the measurement error, the IV estimates are consistent (see, for instance, Johnston and DiNardo 1997). It is therefore reassuring that the estimates of the coefficients for the net replacement rate are close to those in the OLS estimations.

Competing interests
The IZA Journal of Labor Policy is committed to the IZA Guiding Principles of Research Integrity. The authors declare that they have observed these principles.

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