Institute for Fiscal Studies

The return to work and how it is taxed: a dynamic perspective

The payoff to work and how it is taxed: a dynamic perspective

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Abstract: This paper provides an empirical account of the dynamic payoff to work and how it is affected by taxes and transfers. In doing so, we bring the insights from the literature on dynamic labour supply to the issue of estimating the financial payoff to work, which has previously focused solely on the current period return. We do this by developing two new summary statistics – one that measures the dynamic payoff to work and the other that measures the impact of personal taxes and transfers on the dynamic payoff to work – and implement these using simulated data from a sophisticated dynamic model of education and labour supply. At the median, we find that the dynamic payoff to work is almost 30 per cent stronger than a static measure would imply, a very substantial difference. Allowing for behavioural responses undoes much of the impression of stronger incentives for low-educated women but has little impact for high-educated women, further widening the difference in incentives between these groups. In contrast, a dynamic perspective makes relatively little difference to impact of personal taxes and transfers on the payoff to work.

1. Introduction

The labour economics literature has long recognised that work experience, employment and earnings are intimately linked over the course of life (see the seminal contributions by Becker, 1964, Ben-Porath, 1967 and Heckman, 1976, or the overview in Blundell and McCurdy , 1999). One mechanism often cited to explain the links between these three processes is human capital, with employment contributing to the accumulation of experience that is later productive in work, and, conversely, with returns realised in the future shaping the incentives (and decisions) to work and accumulate human capital. The dynamic interactions between current working and future earnings capacity are seldom accounted for in the taxation literature.[2] Yet, the tax and transfer system may interfere with labour supply choices partly by affecting the return to cumulated work experience. Specifically, a progressive system will change the incentives to work by taxing future returns more heavily than current earnings while providing some insurance against earnings risk. These effects may be particularly strong for families with children in the presence of work-contingent subsidies if wage progression associated with the accumulation of human capital moves them into the high effective tax rates associated with means-tested subsidy withdrawal (Heckman, Lochner and Cossa, 2003).

The purpose of this paper is to study how a dynamic perspective affects our view of the payoff to work and how it is treated by the tax and transfer system. Our starting point is that working brings both present and future returns, the latter arising from the accumulation of work experience, and that the tax treatment of these returns depends on the circumstances of the individual.[3] This approach differs from most past research on how taxes and benefits affect work incentives, which has been based on standard static measures that exclude any

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[2] Two recent exceptions are Stantcheva (2016) and Best and Kleven (2013).
[3] Another dynamic perspective would be to consider how work incentives change for an individual as they age; we attempt this in a companion paper, Brewer and Shaw (2018).

sort of dynamic considerations in the form of future returns from working today (Immervoll, 2004; Adam and Browne, 2010; OECD, 2015). This omission seems particularly surprising given that much of the effort dedicated to studying labour supply behaviour is justified by the need to understand better the distortionary effect that modern tax and welfare systems have on labour supply choices and on future earnings capacity. In contrast, recent contributions in the optimal taxation research have increasingly recognised the importance of accounting for the dynamic links between education and earnings (e.g. Bovenberg and Jacobs, 2005; Bohacek and Kapicka, 2008; Anderberg, 2009). Investments in training during the working life have been considered by Stantcheva (2016) while other studies have considered the case for age-dependent taxes in frameworks where wages are exogenously determined (Kremer, 2002; Weinzierl, 2012; Mirrlees et al., 2011). But, to the best of our knowledge, there is as yet no empirical account of the dynamic payoff to work that includes consideration of the role played by taxes and benefits.

To quantify the dynamic payoff to work and how it is taxed, we define two summary measures – the forward-looking replacement rate (FLRR), which measures the payoff to working at all, and the forward-looking participation tax rate (FLPTR), which measures the impact of personal taxes and transfers on the payoff to work.[4] Both measures are defined in a dynamic setting. They depend on the contemporaneous and future returns to employment, through earnings and labour supply, and how these are treated by the tax and transfer system. They interact with changing family circumstances as these affect labour supply decisions, tax liabilities and benefit entitlement. And they inherit the uncertainty in all these processes. For these reasons, these dynamic measures may imply work incentives that differ markedly from their static counterparts.

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[4] Terminology here is not standard: Mulligan (2013) uses the term "marginal tax rate" to refer to what we call the participation tax rate, and when OECD (2015) analyses what it calls "marginal tax rates", it calculates what we call the METR for workers and the PTR for non-workers.

We implement our new measures on simulated data from the empirical dynamic life-cycle model of female labour supply and earnings developed and estimated by Blundell et al. (2016). The focus is on women, who are more responsive to work incentives than men, and for whom time off work and short working hours are especially prevalent and carry potential consequences for the value of working and the accumulation of human capital (Altonji and Blank, 1999; Goldin, 2006, 2014; Meghir and Phillips, 2010; Adda et al., 2015). In the model, employment affects future earnings capacity through the accumulation of experience capital. Women can choose labour supply at the extensive and intensive margins, each carrying different returns through experience. This feature of the model supports a rich characterisation of how the tax and transfer system affects the incentives for different hours of work. The model also formalises the dynamics of family formation, a key driver of women's work decisions that interacts strongly with the tax and welfare system. It accounts for other family income, notably spouse's earnings, and for uncertainty in the different sources of income.

Based on the simulated life-cycle profiles of 22,000 women, we find that the payoff to work at the start of working life is much higher than a static measure would imply: at the median, the dynamic payoff to work (as measured by the FLRR) is almost 30 per cent stronger than the corresponding static measure (the RR), a very substantial difference. This result is driven by returns to experience. The differences drop with age, as experience profiles become flatter and the number of future working periods drops. They are also larger for highly educated women (because returns to experience are more important for this group), for women in families without children (because they have greater labour market attachment) and for younger women. Allowing for behavioural response tends to cancel out much of the impression of strengthened incentives for low-educated women, as their labour supply is very responsive to changes in unearned income (large income effects). This suggests that policy

should focus on low-educated individuals whose work incentives are weaker than those for high-educated individuals and for whom dynamic considerations are unlikely to improve things much.

Although a forward-looking perspective makes a considerable difference to estimates of the payoff to work, we find it makes relatively little difference to the extent to which personal taxes and transfers reduce the payoff to work: we find that the expected FLPTR and static PTR differ relatively little for most women in our data. This mainly because the UK tax and transfer system treats the future returns to working today similarly to how it treats the current-period return. Put differently, for most women the returns to the experience accumulated by one extra working year are not strong enough to move them across a tax or benefit threshold. However, we can identify some groups for whom a forward-looking perspective does change the extent to which the tax and transfer system weakens the payoff to work. Specifically, this happens to young women and lone mothers.

The economic mechanism that underpins our main findings is returns to experience, which we see as accumulating human capital through on-the-job learning. Our mechanism is similar to the one behind the results in Keane (2011). Within an intertemporal model of labour supply, Keane (2011), following Imai and Keane (2004), shows that the welfare losses from income taxation are larger if one allows for endogenous human capital formation through learning-by-doing because higher taxes contemporaneously reduce work, leading to lower levels of accumulated human capital and less output in the future. Keane also shows that, with human capital formation through learning-by-doing, permanent tax changes may induce larger labour supply responses than transitory changes because permanent changes affect the returns to human capital. The model we use also has human capital accumulation through on-the-job learning and generates similar responses, but it extends the models used by Keane by adding an extensive labour supply margin, savings choices that can be used to self-insure

against future employment and earnings risk, a real-world tax and welfare system, and stochastic family dynamics. Our contribution, therefore, is to examine the importance of taking a dynamic perspective for considering the impact of the tax system in a richer and more realistic model with not just endogenous human capital formation through learning-by-doing but also changing family composition, and a real-world, non-convex tax and transfer system that depends heavily on family circumstances. We also show how the dynamic considerations highlighted by Imai and Keane (2004) can be captured in a summary measure of the tax burden.

Section 2 outlines our two new forward-looking measures of the payoff to work and how it is taxed. Section 3 describes the model and data used to implement the measures. Section 4 sets out our results and Section 5 concludes.

2. Forward-looking measures of the payoff to work and how it is taxed

In this section, we define and analyse two summary measures: the forward-looking replacement rate (FLRR), which measures the payoff to working at all, and the forward-looking participation tax rate (FLPTR), which measures the impact of personal taxes and transfers on the payoff to work. These measures are consistent with a dynamic, forward-looking, model of individual labour supply and human capital accumulation. And, as we show in the Appendix, they are natural measures in the context of a simple dynamic labour supply decision problem. In addition, each measure is a dynamic variant to commonly-used measures of static work incentives: the replacement rate (RR) and the participation tax rate (PTR).

2.1. The forward looking replacement rate

The static replacement rate (RR) measures the payoff to working compared to not working.[5] From the point of view of a worker, it describes what fraction of net income would remain if he or she (we use "she" hereafter, as our empirical application is to women) moved out of work. In a discrete time world where a indexes the woman's age, the static RR at h working hours is defined as:

$$RR_a(h) = \frac{Y_a(0)}{Y_a(h)}$$

where $Y_a(h_a)$ is net (of taxes and transfers) income when the woman is aged a, a function of her contemporaneous working hours h_a. Net income Y is typically measured at the family level since this is the unit used to assess entitlement to most benefits. Higher values of RR correspond to a weaker incentive to work.

This conventional RR is therefore a static measure of the payoff to work that considers only the current period. We can define a forward-looking version of the RR that accounts for the dynamic returns to current working. We assume income realisations are annual and use:

$$FLRR_a(h) = \frac{Y_a(0)}{Y_a(h) + \sum_{s=1}^{A-a} R^{-s}[Y_{a+s}(h_{a+s}|h_a = h) - Y_{a+s}(h_{a+s}|h_a = 0)]}$$

where R is the (risk free) interest factor, $a + s$ is the age of the woman in future periods, ranging between $a + 1$ and some terminal age A, and the path of future income is conditional on present labour supply as it affects working experience. The numerator is therefore the reward to not working (net out-of-work income) at age a, and the denominator is the contemporaneous reward to working at age a plus the additional income that accrues because future wages are higher having worked at age a; this latter term itself depends also on future

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[5] It is also used as a measure of the adequacy of retirement incomes or unemployment insurance, but we do not pursue that interpretation here.

levels of labour supply and future personal tax and transfer systems. Clearly, the FLRR is identical to the RR in the final period, at age $a = A$. More generally, if working today bears no consequences for future work or earning capacity, then the FLRR reduces to the RR in every period.[6]

Both the static and the forward-looking measures can be evaluated at different values of labour supply at age a – and so we think of them as describing the functions $RR_a(h_a)$ and $FLRR_a(h_a)$. The FLRR also requires a choice of the future labour supply path $(h_{a+s}, s = 1, \ldots, A - a)$ to calculate future income. Different choices of these future values alter the interpretation of these measures. For example, evaluating $Y_{a+s}(h_{a+s}|h_a = h)$ and $Y_{a+s}(h_{a+s}|h_a = 0)$ at h_{a+s} at the maximum value of labour supply for all $s = 1, \ldots A - a$ would correspond to a full-income concept in future years (as in, for example, Blomquist, 1981). At the other extreme, evaluating $Y_{a+s}(h_{a+s}|h_a = h)$ and $Y_{a+s}(h_{a+s}|h_a = 0)$ at $h_{a+s} = 0$ for all $s = 1, \ldots A - a$ would reduce the FLRRs to its usual static measure. Another alternative is to evaluate $Y_{a+s}(h_{a+s}|h_a)$ at the optimal working hours h_{a+s} conditional on working hours at time a being h_a (either 0 or h). This accounts for the role of future labour supply responses in shaping present returns to working. Two mechanisms drive the responses in future labour supply to changes in present working hours. On the one hand, working accumulates experience that is productive in the future, thus making future work more attractive. However, working is also associated with higher income and higher savings, leading to an income effect that reduces future labour supply. As a result, the overall impact of present work on future working hours is ambiguous, and may vary over the life-cycle and by the characteristics of the woman and her family. A final alternative is to rule out future labour supply responses to the change in experience and savings induced by changes in

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[6] It is important to recognise that an increase in the FLRR need not imply that work this period has become less likely (and vice versa). To see this, consider the case where future taxes go up. This will raise the FLRR all else equal, but may induce the individual to work today due to an intertemporal substitution effect.

current labour supply, but consider future labour supply at the individual's preferred labour supply choice.

The last of these is our preferred choice, so in most of our results, we evaluate $Y_{a+s}(h_{a+s}|h_a = h)$ and $Y_{a+s}(h_{a+s}|h_a = 0)$ at the individual's preferred choice of hours worked at age $a + s$ assuming she did not work at age a. With this choice of income path, we effectively assess the return to a small increment in working experience and how the tax and transfer system treats this return, holding everything else constant. Specifically, the difference between the FLRR and the static RR describes how human capital accumulated through working experience, and productive only in the future, increases the reward to working today. Provided the return to experience is non-negative, then we have $FLRR_a \leq RR_a$.

But one of the main advantages of using simulated data from a life-cycle model of labour supply over using observational data is that we can produce these measures under different labour supply paths, which have different information on how the tax and transfer system changes incentives to work. Such comparisons can reveal important insights into how the forward-looking payoff to work and the impact of the tax and transfer system are affected by alternative assumptions. As a result, in Section 4.2, we consider how behaviour affects our conclusions by evaluating Y_{a+s} at optimal working hours h_{a+s} conditional on actual working hours at time a being h_a (either 0 or h).

As defined above, the FLRR is an *ex post* measure, taken once uncertainty has been realised. We calculate its *ex ante* counterpart, which is defined at age a as the expected value at a of the FLRR over the domain of future income, $E_a[FLRR_a(h_a)]$. At our preferred choice of future labour supply paths, the calculation of $E_a[FLRR_a(h_a)]$ requires the optimal labour supply profile to be computed at each point in the distribution of the unpredictable drivers of labour supply and earnings.

2.2. The forward looking participation tax rate

The participation tax rate (PTR) is a common measure summarising the extent to which the personal tax and transfer system weakens the payoff to work. It describes what fraction of the increase in gross earnings caused by a worker moving into work is lost through increased personal tax liability and reduced transfer payments (and is therefore a tax rate). At age a, for a woman working h hours, it is defined as:

$$PTR_a(h) = 1 - \frac{Y_a(h) - Y_a(0)}{E_a(h) - E_a(0)}$$

where $E_a(h_a)$ is gross (before taxes and transfers) income at the family level when the woman is aged a, a function of her contemporaneous working hours h_a, and Y and h are defined as above. Higher values mean that the personal tax and transfer system reduces the payoff to work by more. We note that the RR is a measure of the payoff to work, whereas the PTR is a measure of the impact of the personal tax and transfer system on the payoff to work.

Analogous to the FLRR, we define a forward-looking participation tax rate (FLPTR) that takes into account the dynamic consequences of working today. For an individual at age a, it is defined as:

$$FLPTR_a(h) = 1 - \frac{\sum_{s=0}^{A-a} R^{-s}[Y_{a+s}(h_{a+s}|h_a = h) - Y_{a+s}(h_{a+s}|h_a = 0)]}{\sum_{s=0}^{A-a} R^{-s}[E_{a+s}(h_{a+s}|h_a = h) - E_{a+s}(h_{a+s}|h_a = 0)]}$$

The numerator (denominator) now measures the change in net (gross) income today and in all future periods that results from working today, and the FLPTR is the fraction of current and future earnings that is offset by current and future increases in personal tax liabilities net of entitlements to transfer payments.

Straightforward algebra reveals that we can write the FLPTR as a weighted average of today's PTR and future tax rates (which are marginal effective tax rates) for those future periods in which earnings are higher thanks to the individual working today:

$$FLPTR_a(h) = \alpha_a PTR_a(h) + \sum_{s \in S, s \neq 0} \alpha_{a+s} METR_{a+s}(h) \qquad (1)$$

where:

$$\alpha_{a+s} = \frac{R^{-s}[E_{a+s}(h_{a+s}|h_a = h) - E_{a+s}(h_{a+s}|h_a = 0)]}{\sum_{t \in S} R^{-t}[E_{a+t}(h_{a+t}|h_a = h) - E_{a+t}(h_{a+t}|h_a = 0)]}$$

$$METR_{a+s}(h) = 1 - \frac{Y_{a+s}(h_{a+s}|h_a = h) - Y_{a+s}(h_{a+s}|h_a = 0)}{E_{a+s}(h_{a+s}|h_a = h) - E_{a+s}(h_{a+s}|h_a = 0)}$$

$$S = \{s = 0, \dots, A - a: E_{a+s}(h_{a+s}|h_a = h) - E_{a+s}(h_{a+s}|h_a = 0) \neq 0\}$$

and where terms are omitted if $E_{a+s}(h_{a+s}|h_a = h) - E_{a+s}(h_{a+s}|h_a = 0) = 0$, i.e. if earnings at age $a + s$ are not affected by the decision to work today (which would occur if the individual did not work at age $a + s$, for example).

These future tax rates, $METR_{a+s}(h)$ for *s>0*, are calculated on the change in future earnings that arises due to working at age a, and the weights at age $a + s$ depend on the size of the change in future earnings at age $a + s$. In our preferred implementation, the change in earnings at age $a + s$ reflects only the increase in hourly wages at age $a + s$ that arises from working at age a, and so the age profile of change in future earnings reflects the interaction of the age profile of experience effects and the age profile of future labour supply.

Equation (1) means that whether the FLPTR exceeds the static PTR will depend upon the time profile of future METRs, their relationship to the static PTR, and on the size of the change in future earnings through working today relative to the current-period reward. For example, a FLPTR is more likely to exceed a static PTR for those whose future (static) METR exceeds the current (static) PTR. In a progressive tax system, this is likely hold when the static METR increases with age, possibly due to large experience effects on wages.

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As with the FLRR, we measure the ex ante counterpart at age a as the expected value at a of the FLPTR over the domain of future income, $E_a[FLPTR_a(h_a)]$.

3. Model, data and implementation[7]

To characterise the incentive to work that frame the labour supply decisions of forward-looking individuals one needs to observe the returns to work as they are realised, over future periods. *Ex ante* measures further require knowledge of the uncertainty surrounding these future returns. In this section we briefly describe the construction of the lifetime working and earnings histories that underlie our estimates of the payoff to work and how it is taxed.

3.1 Description of the model

We construct our new forward-looking measures with complete working life data simulated using the structural life-cycle model of labour supply and human capital formation developed and estimated by Blundell et al. (2016, from now on BDMS). This model includes a particularly rich characterisation of the dynamic nature of individual choices and outcomes, making it especially well suited to study the role of taxes and benefits in shaping the financial incentives to work in a dynamic context. For completeness, we describe the BDMS model in some detail here.

The model formalises individual inter-temporal decisions over education, labour supply, savings, and their consequences for human capital formation, earnings and family income. It builds of the tradition of Eckstein and Wolpin (1989), Shaw (1989) and Keane and Wolpin (1997), but with additional features that make it suitable to assess forward-looking returns to work. The most important of these are: evolving family composition; endogenous human capital formation in work through the accumulation of experience capital, and a rich

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[7] Some of this text draws on Brewer and Shaw (2018), which analyses data produced by the same model.

characterisation of the personal tax and transfer system that relies on an accurate UK personal tax and transfer calculator.

Our focus is on women, who have been found to be more responsive to work incentives than men are (Meghir and Phillips, 2010 or Keane, 2011), and are also more vulnerable to poverty partly as a consequence of periods out of work due to family responsibilities. We therefore expect that the dynamic financial incentives to work may be a stronger determinant of labour supply for women than for men.

Although the model describes both the education choices of young adults and their later participation in the labour market, here we focus on the latter as this paper does not study the incentives to invest in education. Hence, all our analysis is conditional on educational attainment, of which we consider three levels: secondary education or leaving school without qualifications, high school qualifications, and college degree (3 years or more).

We consider the working life of women from the age of 19 onwards for those with secondary and high school qualifications, and from the age of 22 for college graduates. Women's choices are modelled on an annual basis. In each period, women choose how much to save and work. Labour supply is limited to three points: not working, part-time work and full-time work, which correspond to 0, 20 and 40 hours of work per week, respectively. Women working different hours will accumulate different amounts of experience capital, as will women with different levels of education. Education attainment also determines the type of human capital a woman has to offer in the labour market and commands a wage premium. Taken together, these two model features imply that education affects both the wage level and its progression, interacting with working experience. Indeed, estimates presented in Blundell et al. (2016) imply that the return to experience is twice as high for women with

higher education than for women with basic education. This will turn out to be important for our later results.

The value of work experience depends on women's family circumstances and how these interact with the tax and transfer system. In the model, family composition changes according to a stochastic but exogenous processes of partnering and childbearing. At age 60, individuals compulsorily retire, and choose how much to consume each period until the end of life at age 69.

The model assumes that women are risk averse, and face uncertainty over future productivity and family demographics. Insurance markets are incomplete, and partial self-insurance is possible through saving and the accumulation of human capital (work experience). Moreover, it is also assumed that human capital cannot be used as collateral, so women are unable to borrow. This set-up means that the tax and transfer system may be of value to individuals both by providing insurance and by alleviating credit constraints.

As mentioned above, the economic mechanism that underpins our results is returns to experience. It is therefore important that the model can separate experience effects from unobserved components of wages that do not depend on labour supply but may influence it. In order to identify experience effects, BDMS relies on major tax and transfer reforms taking place over a period of 18 years together with long longitudinal data that follows various cohorts over the same period. These cohorts are observed through the same sequence of tax and transfer systems, their labour supply and wages being observed both before and after each reform for cohorts in their working years. Identification then relies on comparing different cohorts, who experience the reforms at different stages of their lives. A key identifying assumption is that cohorts have the same preferences towards work and working hours, and that differences in labour supply across cohorts are due to the different policy

environments they experience at each stage of life. Identification also requires reforms capable of influencing the labour supply choices of women with different earnings capacity – say due to differences in education attainment or earnings ability. The observation period used for estimation runs over key changes in support for non-working women, in-work benefits and income taxes. While the former is most relevant to low income families, in-work benefits were extended to families in the middle of the income distribution and changes income taxation affected higher income families most (see BDMS for further details).

Figure 1. Mean log hourly wages by education for working women over the life-cycle: data (solid line) versus model (dashed line)
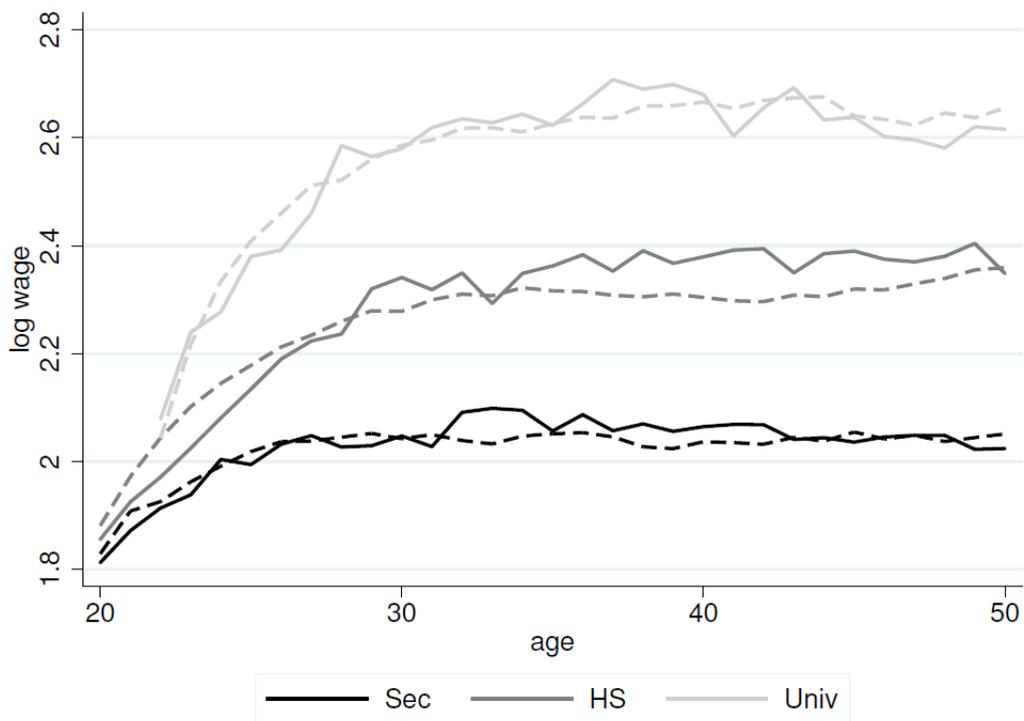
Source: BDMS.

The model is estimated on long longitudinal data from the British Household Panel Survey. Figure 1 contrasts the average log wage profiles observed in the data with model predictions. It shows that the model captures the data patterns well. It also demonstrates that the wage profiles of educated women are steeper than those of lower educated women – a consequence of increasing value of experience with education and the lower prevalence of time off paid

work among educated women, precluding depreciation. The flattening out of the wage profiles that happens early in the working life even among university graduates is in part because of the increasing prevalence of part-time work during the main child-rearing years. BDMS estimate that part-time work carries a strong penalty that affects earnings capacity as illustrated in Figure 2. As compared to full-time hours, working part-time hours continuously from the age of 30 will reduce the earnings capacity of university graduates by around 45% after 30 years, when they reach 60. The effect is smaller for less educated women, reflecting the comparatively lower importance of work experience in driving their wages.

Figure 2 – Experience gap for women in part-time work from the age of 30; by education.
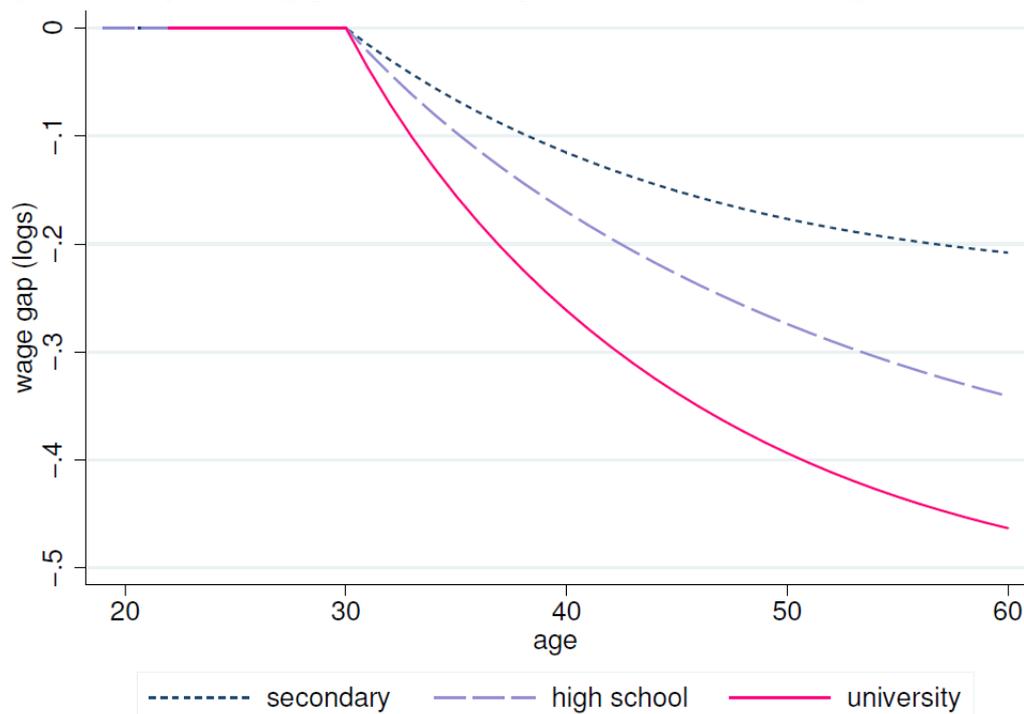
Source: BDMS.

3.2. Simulated data

Using the model, we simulate full lifecycles for 22,000 women and their families. These are constructed by randomly drawing initial conditions (age 17) from the BHPS data, and then, for each woman, randomly drawing lifecycle profiles for the exogenous components of the model (productivity and family composition) and solving the decision problem at each age.

The result is a lifecycle profile for each simulated individual for each of the exogenous and endogenous variables in the model (e.g. labour supply, consumption, assets, experience and education, plus the work incentive measures). The population we simulate is, effectively, all families containing an adult female (single men are the only excluded family type).

When performing these simulations, we assume individuals face a single tax and transfer system throughout life: that in operation in the UK as of April 2012. This combines a relatively simple, individual-based, income tax system with a relatively complicated, family-based set of transfer payments and refundable tax credits for which maximum entitlements are strongly influenced by family circumstances and there is a heavy reliance on means-testing (for more detail, see Pope and Roantree (2014) and Hood and Oakley (2014)). The way that the personal taxes affect work incentives is fairly intuitive, but the cash benefits and refundable tax credits affect work incentives in much more complicated ways, meaning that the impact they have on a given individual's work incentives will depend upon the earnings of any partner, and on other family or household characteristics, such as the presence and age of children, and housing tenure. The April 2012 system is implemented using an accurate UK tax and transfer calculator called FORTAX (see Shephard, 2009 and Shaw, 2011).

Simulated data has a number of advantages relative to using panel survey data. The first is practical: it enables us to analyse complete lifecycles. Using UK panel data, we would be limited to half a full working life at most: the UK's longest-running panel dataset (the British Household Panel Survey and its successor) has existed only since 1991, and only a small fraction of the sample has been interviewed in every wave. Second, patterns observed in panel data will be confounded by changes in institutions over time, as well as cohort effects, whereas we can model cleanly how women would behave as if they faced a constant personal tax and transfer system throughout life, and can do so having stripped out cohort effects.

Third, we can use the model to calculate our new forward-looking measures of the payoff to work, taking into account the uncertainty that individuals face.

3.3. Practical implementation of the forward-looking measures of the payoff to work

We calculate the FLPTR and FLRR for workers setting h_a to their observed current-period number of hours worked; for non-workers we set h_a equal to the number of hours individuals would have worked had they been employed – something we know because the model gives us a complete ranking for the different choices of hours. Income is the combined income of a family (woman plus partner if she has one), after deducting personal taxes and adding transfer payments. We treat childcare costs like a tax liability, effectively assuming that spending on childcare is a cost of working that would not otherwise be incurred, and does not in itself affect the family's utility. When calculating the FLRR and FLPTR, we use total family earnings and income (not equivalised).[8]

4. Results

4.1. The forward-looking replacement rate holding behaviour fixed

Table 1 compares means and medians for the conventional, current-period-only, measure of payoff to work (the RR) and our new forward-looking measure of the payoff to working in the current period (the expected FLRR), holding behaviour fixed. On average, the expected FLRR is substantially lower than the RR, indicating that the forward-looking payoff to work is much stronger than the static return. This is particularly true at the start of working life (second row): at the mean, the expected FLRR is 8 percentage points lower than RR (0.383 vs. 0.463) – a difference of almost a fifth – while the median it is 10 percentage points lower (0.273 vs. 0.377) – a difference of almost 30 per cent. As Section 3 discussed, this highlights

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[8] Equivalisation makes no difference to the RR and PTR because it cancels from the numerator and denominator. While this isn't true for the FLRR and FLPTR, in practice, it makes little difference.

that the effect of experience are most important at the start of working life where experience profiles are steepest and there are more future periods in which women can benefit from the experience effects caused by working today.[9]

Table 1. Mean and median RR and expected FLRR holding behaviour fixed

	Mean		Median	
	RR (1)	FLRR (2)	RR (3)	FLRR (4)
Overall	0.542	0.513	0.546	0.512
Start of working life	0.463	0.383	0.377	0.273

Notes: authors' calculations based on simulated data.

Figure 3 shows that similar differences exist across the bottom 80% of the distribution. The figure plots cumulative distributions of RRs and expected FLRRs, the left panel for all working-age women and the right panel for women at the start of working life.

Figure 3. Cumulative distribution of RRs and expected FLRRs
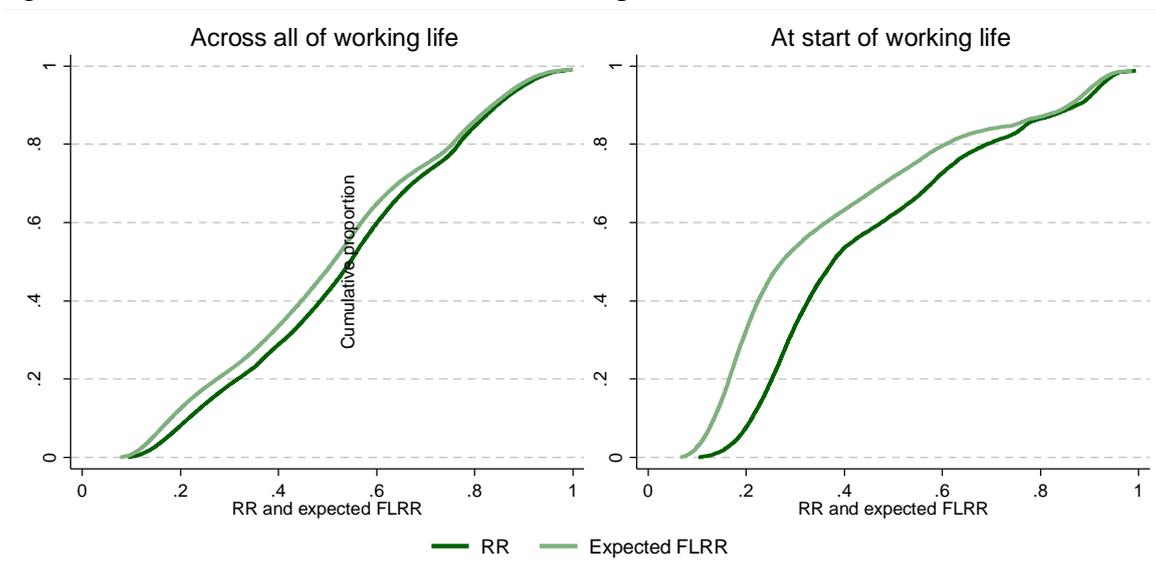
Notes: authors' calculations based on simulated data.

As shown in Table 2, there is also important variation across demographic groups in the difference between the expected FLRR and the RR, reflecting both wage differentials due to

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[9] Imai and Keane (2004) similarly find that allowing for endogenous human capital formation makes more of a difference to younger workers than older workers in terms of the size of tax-induced distortions (see their Figure 7).

experience and varying treatment by the tax and transfer system across families in different circumstances. Column (1) of Table 2 shows the mean difference between the expected FLRR and the RR, while columns (2) to (4) show various percentiles of the distribution of differences. Negative values indicate that the expected FLRR is below the RR (all differences are non-positive when behaviour is held fixed because $RR_a \geq FLRR_a$ given that returns to experience are non-negative). Columns (5) and (6) give the proportion of observations where the expected FLRR is more than five and 10 percentage points below the RR respectively.

Column (1) shows there is a greater divergence between the mean expected FLRR and the mean RR the more education individuals have: -3.9 percentage points for women with higher education, compared to -1.7 percentage points for women with basic education. The mean difference between the expected FLRR and the RR also tends to be larger for women in families without children and for younger women. Indeed, columns (5) and (6) show that, at the start of working life, more than 70 per cent of women have a difference between their expected FLRR and their RR of at least 5 percentage points; over a third have a difference of more than 10 percentage points.

These groups with larger differences are the ones with greater labour market attachment, with more periods of working life ahead of them and for whom experience effects are also larger – and hence the future opportunity cost of taking time off today is higher. Put differently, the differences between the forward-looking and static measures of the payoff to work are larger for groups with lower RRs. As a result, dispersion across groups in the FLRR is greater than in the RR (as suggested by Figure 3). This is driven by two mechanisms: (i) lower RRs are associated with higher current wages and higher future employment; and (ii) experience is complementary with other drivers of wages, such as education or ability, so those with higher wages also benefit more from experience.

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Table 2. Mean and percentiles of the difference between the expected FLRR and RR

	Mean	25th	50th	75th	> 5 ppts	> 10 ppts
	(1)	(2)	(3)	(4)	(5)	(6)
Overall	-0.029	-0.042	-0.023	-0.010	0.167	0.019
Start of working life	-0.080	-0.110	-0.083	-0.047	0.729	0.353
By education						
Basic	-0.017	-0.025	-0.012	-0.006	0.044	0.002
Intermediate	-0.035	-0.048	-0.031	-0.014	0.222	0.030
Higher	-0.039	-0.051	-0.036	-0.019	0.270	0.026
By family type						
Childless single	-0.037	-0.049	-0.031	-0.016	0.244	0.046
Childless couple	-0.029	-0.040	-0.024	-0.011	0.146	0.015
Lone mother	-0.020	-0.028	-0.012	-0.006	0.108	0.006
Couple parent	-0.027	-0.040	-0.021	-0.009	0.143	0.007
By age band						
20s	-0.039	-0.056	-0.036	-0.012	0.325	0.040
32s	-0.028	-0.043	-0.024	-0.010	0.150	0.006
40s	-0.030	-0.041	-0.029	-0.015	0.132	0.007
50s	-0.016	-0.023	-0.013	-0.006	0.025	0.002
Wage quartile (all women)						
Bottom	-0.022	-0.028	-0.011	-0.005	0.127	0.033
2nd	-0.031	-0.045	-0.022	-0.010	0.207	0.027
3rd	-0.033	-0.045	-0.031	-0.015	0.195	0.014
Top	-0.031	-0.042	-0.029	-0.017	0.139	0.003
Wage quartile (workers)						
Bottom	-0.032	-0.044	-0.021	-0.009	0.209	0.057

	Mean	25th	50th	75th	> 5 ppts	> 10 ppts
2nd	-0.034	-0.049	-0.027	-0.012	0.243	0.027
3rd	-0.035	-0.047	-0.033	-0.017	0.209	0.014
Top	-0.031	-0.042	-0.030	-0.017	0.141	0.003
Hours of work						
Zero	-0.016	-0.016	-0.009	-0.005	0.064	0.016
Part time	-0.011	-0.014	-0.010	-0.007	0.000	0.000
Full time	-0.037	-0.048	-0.033	-0.020	0.227	0.023

Notes: authors' calculations based on simulated data. The column headed "Mean" is the average value of the expected FLRR less the RR, so negative values indicate that the expected FLRR is lower than the RR. Since the return to experience is non-negative, the expected FLRR cannot exceed the RR when behaviour is held fixed. The columns headed "25th", "50th" and "75th" are the corresponding percentiles of the distribution of differences between the expected FLRR and RR. The columns headed "> 5 ppts" and "> 10 ppts" give the proportion of observations where the expected FLRR is more than five and 10 percentage points below the RR respectively.

4.2. The forward-looking replacement rate allowing behaviour to respond

So far, we have held behaviour fixed when calculating our forward-looking measure of the payoff to work. In this section we show how conclusions are affected by allowing behaviour to respond to the change in current labour supply.

Current labour supply affects future incentives to work in two ways: (i) it may increase the incentive to work in the future by raising experience capital and thereby the opportunity cost of leisure, but (ii) it may reduce the incentives to work in the future if working leads to higher savings and higher future earnings due to the accumulation of experience capital. Which effect dominates depends on how strong the experience and income effects are. For the purpose of our analysis, if working today leads to higher future employment or hours, accounting for behavioural responses would further reduce the FLRR. But the reverse is true if current work (partly) substitutes for future work. Very few papers account for the two mechanisms when looking at inter-temporal labour supply choices; Keane (2011) derives in a stylised framework how the two mechanisms affect the responses to temporary and

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permanent tax changes; Blundell et al (2016) allow for both mechanisms in their dynamic model of women labour supply.

Estimates of our simulated model show strong experience effects, particularly for young and educated individuals. Table 3 sets out the parameter values, which imply that a 10% increase in experience equates to a 1.6%, 2.5% and 3.0% increase in the wage rate for individuals with secondary, high school and university education respectively.

Table 3. Estimated return to experience in life-cycle model

	Secondary (1)	High school (2)	University (3)
Mean value of coefficient on experience	0.16	0.25	0.30

Notes: taken from Table VIII in Blundell et al. (2016).

Using model simulations, we calculated the Marshallian elasticities of labour supply (which roughly capture the effects of experience on labour supply, because experience induces a permanent change in wages) and the income effects. These are set out in Table 4. Both are relatively large but vary substantially with demographics. What this means is that the direction of the change in the FLRR from incorporating behaviour is a priori unknown. If the income effect is sufficiently large and the experience effect sufficiently low for some specific groups (such as low educated lone mothers), then current work may actually lead to lower labour supply in the future as they transfer labour supply across periods. This would cancel out the strengthening of the incentive to work under the forward-looking measure without behavioural response.

Figure 4 sets out our simulated estimates. The left-hand panel is for secondary educated individuals. Comparing the FLRR without behavioural response to the RR reveals that the effect of experience on future wages is small throughout life for this group (the two lines are very close), consistent with what we saw in Table 2. In addition, the impact of experience on

labour supply is dominated by the income effect, leaving the FLRR with behavioural response almost identical to (or, for some age groups, even higher then) the RR. The middle panel is for high-school educated individuals. Here, income effects are more modest, offsetting part of the impression of a higher payoff to work from taking a forward-looking perspective. In contrast, the right-hand panel for university educated individuals suggests that the role of income effects and experience effects for labour supply roughly cancel out: present work has little effect on future labour supply. Both with and without behaviour, the forward-looking payoff to work is substantially stronger than the static return for university-educated individuals. Profiles across all three education groups display a marked hump-shaped profile; this is the consequence of more generous state support for families during the main child-rearing years.

Table 4. Estimated Marshallian elasticities and income effects in life-cycle model

	Secondary (1)	High school (2)	University (3)
Marshallian elasticities			
Childless single	0.694	0.392	0.260
Childless couple	0.320	0.188	0.175
Lone mother	2.017	1.244	0.555
Couple parent	0.723	0.477	0.488
Income effects			
Childless single	-0.449	-0.544	-0.548
Childless couple	-0.206	-0.111	-0.167
Lone mother	-0.851	-0.799	-0.336
Couple parent	-0.349	-0.340	-0.337

Notes: taken from Table XIV in Blundell et al. (2016) and authors' calculations.

Figure 4. Median RR, expected FLRR without behavioural response and expected FLRR with behavioural response, by age and education
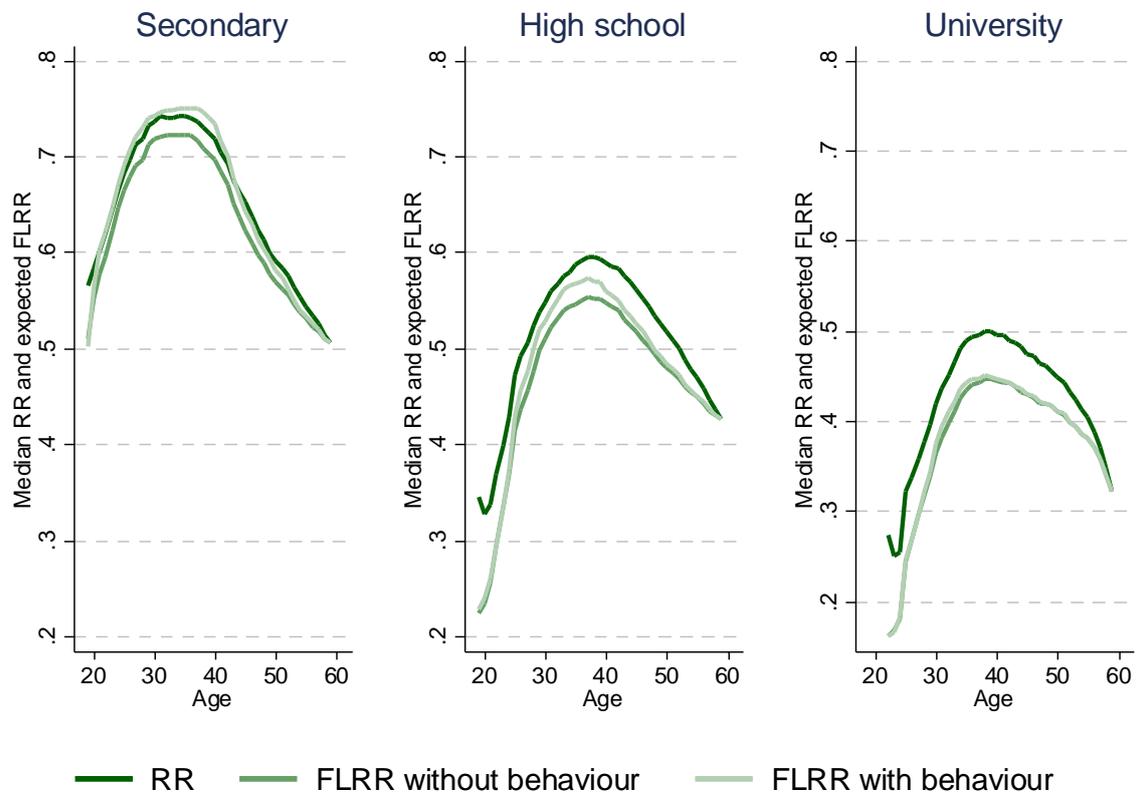
Notes: authors' calculations based on simulated data.

These results have important policy implications. In particular, they suggest that policy should focus on low-educated individuals whose work incentives are weaker than those for high-educated individuals and for whom dynamic considerations are unlikely to improve things much. Our findings also imply that that temporarily improving the payoff to work is not likely to lead to more employment over the entire life for any education group. For low educated women, a temporary improvement in the payoff to work is likely to lead to a substitution of labour supply across periods of life. This is driven by small experience effects that these women face, as well as by their high responsiveness to income. In turn, temporarily increasing the incentives to work of more educated women will increase their overall labour supply but may not lead to future gains in employment, once the additional incentive is dropped. This happens despite the large experience effects that educated women experience,

and is due to the fact that they are much less responsive to additional changes in their wage rate given their comparatively high returns to work (and, hence, their high employment rates).

4.3. The forward-looking participation tax rate holding behaviour fixed

We now turn to the impact of the tax and transfer system on the payoff to work. Table 5 compares means and medians for the conventional, current-period-only, measure of the effect of taxes and transfers on the payoff to work (the PTR) and our new forward-looking measure (the expected FLPTR), holding behaviour fixed. In contrast to the results for the RR/FLRR, here we find little impact from taking a forward-looking perspective.

Overall, the difference across the whole of working life is negligible at around -0.1 percentage points at the mean and -0.6 at the median. From the perspective of the start of working life, the differences are somewhat larger but still modest: -2.1 percentage points at the mean and -3.3 percentage points at the median. Thus, at least on average, our impression of the impact of taxes and transfers on the payoff to work doesn't change much when moving to a forward-looking perspective.

Table 5. Mean and median PTR and expected FLPTR holding behaviour fixed

	Mean		Median	
	PTR (1)	FLPTR (2)	PTR (3)	FLPTR (4)
Overall	0.368	0.368	0.382	0.376
Start of working life	0.446	0.425	0.425	0.392

Notes: authors' calculations based on simulated data.

Figure 5 shows that there are similarly small differences between the expected FLPTR and the PTR across the distribution, and even when assessed from the perspective of the start of working life (right-hand panel).

Figure 5. Cumulative distribution of PTRs and expected FLPTRs holding behaviour fixed
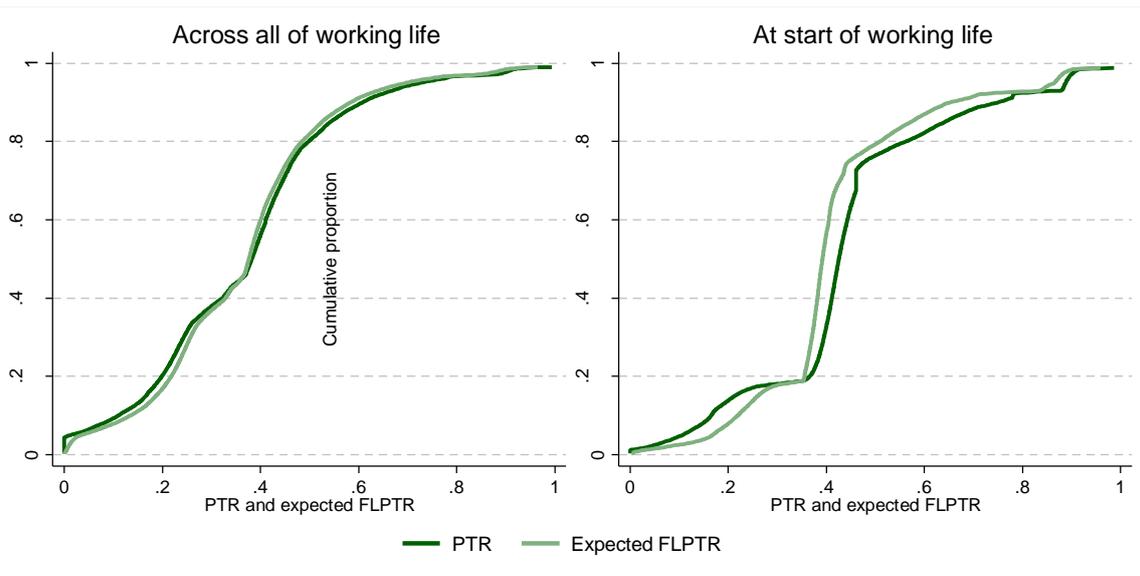
Notes: authors' calculations based on simulated data.

There are two main reasons why the expected FLPTR and PTR differ relatively little. First, the majority of the payoff to working today is received in the current period. Table 6 presents a decomposition of the overall expected FLPTR according to equation (1). On average, the weight α_a on the current-period PTR is 88 per cent, meaning that the expected FLPTR is inevitably dominated by the value of the current-period PTR.

Second, current and future returns tend to be treated fairly similarly, on average, by the UK personal tax and transfer system. The second row of Table 6 shows that the average value of the current-period PTR is 0.369. Subsequent rows break down the mean tax rates on future earnings according to the woman's future family circumstances, something which makes a considerable difference to how earnings are taxed in the UK personal tax and transfer system. They show that only for future periods in which women will be single mothers is there much difference between future and current tax rates on earnings, but these periods receive a weight of only 1 per cent when assessed across all working-age women.

Table 6. Decomposition of expected FLPTR across all of working life

	Weight (α_{a+s})	Tax rate
Expected FLPTR	1.000	0.368
Current PTR	0.878	0.369
Future METR		
Childless single	0.038	0.355
Childless couple	0.038	0.322
Lone mother	0.010	0.576
Couple parent	0.036	0.343

Notes: authors' calculations based on simulated data. The decomposition in this table corresponds to that set out in equation (1) but where future METR terms have been grouped according to family type. The expected FLPTR is equal to the product of entries in the "Weight" and "Tax rate" columns, summed together. Average future METRs are weighted averages.

Although the mean difference between the expected FLPTR and the PTR is relatively small, Table 7 demonstrates there is some variation for specific subgroups. Unlike with the RR, the FLPTR may be either above or below the PTR. So to assess the extent to which the FLPTR and PTR diverge at the individual level, column (2) shows the mean absolute difference between the expected FLPTR and the PTR according to woman's characteristics. At the start of working life, this difference is a fairly substantial 3.9 percentage points. The absolute difference is smaller for women with basic education because returns to experience for this group are low: the mean absolute difference is 1.2 percentage points, compared to 1.8 percentage points for women with intermediate education and 1.7 percentage points for higher-educated women. The mean absolute difference is also smaller for older women than younger women; as with the expected FLRR, this is partly because there are fewer periods of working life left, but also because the experience profile flattens out at higher levels of experience.

Table 7. Mean absolute difference between the expected FLPTR and PTR

	Mean	Mean absolute	> 5 ppts	> 10 ppts
	(1)	(2)	(3)	(4)
Overall	-0.001	0.016	0.038	0.004
Start of working life	-0.021	0.039	0.258	0.049
By education				
Basic	0.000	0.012	0.020	0.001
Intermediate	-0.002	0.018	0.052	0.006
Higher	-0.001	0.017	0.034	0.004
By family type				
Childless single	-0.015	0.017	0.052	0.006
Childless couple	0.010	0.016	0.041	0.004
Lone mother	0.009	0.018	0.049	0.006
Couple parent	-0.001	0.014	0.019	0.001
By age band				
20s	-0.005	0.021	0.067	0.006
30s	-0.001	0.016	0.026	0.001
40s	0.002	0.017	0.032	0.004
50s	0.002	0.009	0.010	0.001

Notes: authors' calculations based on simulated data. The column headed "Mean" is the average value of the expected FLPTR less the PTR, so negative values indicate that the expected FLPTR is lower than the PTR. The "Mean absolute" column is the average absolute value of the expected FLPTR less the PTR. The columns headed "> 5 ppts" and "> 10 ppts" give the proportion of observations where the expected FLPTR and the PTR differ by more than five and 10 percentage points respectively.

There are also some groups of women for whom substantial differences exist between the expected FLPTR and the PTR. Columns (3) and (4) of Table 7 show the proportion of women with large (more than 5 percentage points and more than 10 percentage points) absolute differences, split by various characteristics. Most notable are the results from the

perspective of the start of working life: 26 per cent of women have an absolute difference of at least 5 percentage points and 5 per cent have an absolute difference of 10 percentage points or more. By education, women with intermediate education have the largest share with an absolute difference of at least 5 percentage points, and by age band it's those in their 20s. By family type, childless singles and lone mothers have the greatest share of absolute differences that exceed 5 percentage points (both around 5 per cent), followed by childless couples (4 per cent).

Table 8. Decomposition of expected FLPTR across all of working life for lone mothers whose expected FLPTR exceeds their PTR by at least 5 percentage points

	Weight (α_{a+s})	Tax rate
Expected FLPTR	1.000	0.250
Current PTR	0.804	0.173
Future METR		
Childless single	0.053	0.501
Childless couple	0.009	0.330
Lone mother	0.108	0.660
Couple parent	0.025	0.397

Notes: authors' calculations based on simulated data. The decomposition in this table corresponds to that set out in equation (1) but where future METR terms have been grouped according to family type. The expected FLPTR is equal to the product of entries in the "Weight" and "Tax rate" columns, summed together. Average future METRs are weighted averages. Excludes a small number of cases where the difference between expected FLPTR and PTR exceeds 2.

Among lone mothers, more than 90 per cent of absolute differences greater than 5 percentage points involve the expected FLPTR exceeding the PTR, meaning that a forward-looking assessment of how much the reward to working now is taxed reveals a higher tax rate than the current period's average tax rate. Table 8 decomposes the expected FLPTR for this group following equation (1). Much of the difference is caused by future METRs for lone mothers being much higher than the current PTR (0.660 compared to 0.173). This reflects a structural

feature of the way that the UK personal tax and transfer system affected lone mothers: thanks to generous refundable in-work tax credits, the average net tax rate on part-time or low-earning jobs can be low, but when these in-work tax credits are withdrawn from those on higher incomes, the combined METR can easily exceed 60 per cent.

Table 9. Decomposition of expected FLPTR across all of working life for women in childless couples whose expected FLPTR exceeds their PTR by at least 5 percentage points

	Weight (α_{a+s})	Tax rate
Expected FLPTR	1.000	0.186
Current PTR	0.689	0.118
Future METR		
Childless single	0.033	0.345
Childless couple	0.194	0.315
Lone mother	0.012	0.604
Couple parent	0.073	0.349

Notes: authors' calculations based on simulated data. The decomposition in this table corresponds to that set out in equation (1) but where future METR terms have been grouped according to family type. The expected FLPTR is equal to the product of entries in the "Weight" and "Tax rate" columns, summed together. Average future METRs are weighted averages. Excludes a small number of cases where the difference between expected FLPTR and PTR exceeds 2.

For women in childless couples with absolute differences greater than 5 percentage points, it is also the case that the majority (over 75 per cent) have an expected FLPTR that exceeds the PTR, meaning that a forward-looking assessment of how much the reward to working now is taxed reveals a higher tax rate than the current period's average tax rate. As with lone parents in similar situation, a decomposition of the expected FLPTR (Table 9) according to equation (1) reveals that, for these women, the PTR on current earnings is very low (0.118) in absolute terms, and certainly low compared to future METRs. For this group of women, the low current-period PTRs arise because they are likely not to be entitled to any transfer payments if they do not work (as most will be married to working men), and so their current period

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PTR is low, reflecting simply the average net tax rate coming from the personal tax system. Because the UK tax system has a large tax-free allowance and progressive structure, this PTR is lower than any METR that would apply to the reward to working today that accrues in future periods.

5. Conclusion

In this paper, we bridge the gap between the literature on dynamic models of labour supply and on assessing the strength of work incentives. Our argument is straightforward: the insight of the forward-looking models of labour supply is that part of the payoff to working today is realised in future periods, usually conceptualised as acting through experience accumulation. This should be taken into consideration when measuring work incentives. We therefore propose new measures of the payoff to work and how it is taxed that incorporates dynamic considerations.

Our empirical analysis of these measures is based on the simulated working lives of 22,000 women who are representative of new entrants to labour market in the UK over the period 1991 to 2006. The behaviour of these individuals is simulated using a sophisticated, structural dynamic model of education and labour supply that incorporates evolving family composition; a rich characterisation of the personal tax and transfer system; an education choice; and experience accumulation.

We showed that the true payoff to working at the start of working life is much higher than a static measure of work incentives would imply: at the median, the dynamic payoff to work (measured by the expected FLRR) is almost 30 per cent stronger than the corresponding static measure (the RR), a very substantial difference. These results are driven by returns to experience. The difference between the expected FLRR and the RR tends to be greater for women in families without children (because they have greater labour market attachment, on

average, than those with children) and for younger women (whose experience profiles are steeper, on average, and who have more periods of working life ahead of them, than older women). When allowing future labour supply to respond to the change in current labour supply, we showed that there are important differences across education groups. For those with low education, the impression of a stronger incentive to work from taking a forward-looking perspective is wiped out; for those with high education, however, the improved incentive remains intact – further widening the difference in incentives between these groups. These patterns are the result of differences across education groups in the importance of experience effects and income effects in determining future labour supply. These findings suggest that policy should focus on low-educated individuals whose work incentives are weaker than those for high-educated individuals and for whom dynamic considerations are unlikely to improve things much. They also imply that policy reforms that temporarily strengthen the payoff to work are not likely to lead to more employment across life for any education group.

We also showed that a forward-looking perspective makes smaller differences to our impression of the effective tax rate that applies to the decision to work today. This relative lack of difference arises because the payoff to work is dominated by the current-period wage and because the UK personal tax and transfer system treats the future payoff to working today similarly to the current-period return on average. Two groups where the forward-looking perspective is different from the conventional current-period PTR are for women living in couples but without children, and for lone mothers; in both cases, the more common pattern is for the FLPTR to exceed the conventional current-period PTR.

That there is no contradiction in finding that the expected FLPTR and PTR differ by much less than the expected FLRR and RR: the RR and FLRR are measures of work incentives, while the PTR and FLPTR are measures of the effect of taxes and benefits on work

incentives. Future returns to experience from working today always act to reduce the FLRR, but their effect on the FLPTR depends on how they are treated by future tax and transfer system. What our results say, therefore, is that a forward-looking perspective makes work look considerably more attractive, on average, but our view of the distortionary impact of the personal tax and transfer systems changes little.

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A. Appendix

In this Appendix, we show that the FLRR and FLPTR are appropriate measures of the incentive to work and the effect of the tax and transfer system on the incentive to work in a simple dynamic setting.

Suppose the individual makes a continuous consumption choice each period $t = 1, \ldots, T$ and a discrete labour supply choice $l_1 \in \{0,1\}$ in period 1.

The individual's decision problem is then:

$$\max_{c_t, l_1} \sum_{t=1}^{T} \beta^{t-1} u(c_t) - v(l_1) \quad \text{subject to} \quad \sum_{t=1}^{T} \left(\frac{1}{1+r}\right)^{t-1} c_t = LY(l_1)$$

where $v(l)$ is the utility cost of working, $LY(l)$ is the lifetime income associated with a given period-1 labour supply choice, and all other symbols have their standard meaning. $LY(1)$ potentially incorporates both the current period payoff to work (the wage) as well as future returns to work (higher wages due to returns to experience).

Denote the maximised value conditional on working in period 1 as $V(1)$ and the maximised value conditional on not working in period 1 as $V(0)$.

Holding l_1 fixed, the first order conditions for a optimal consumption are:

$$u'(c_t) = \beta(1+r)u'(c_{t+1}) \quad \text{for } t = 1, \ldots, T-1$$

$$\sum_{t=1}^{T} \left(\frac{1}{1+r}\right)^{t-1} c_t = LY(l_1)$$

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The optimal l_1 will then be determined by a comparison of $V(1)$ and $V(0)$.

Suppose for simplicity that $\beta = \frac{1}{1+r}$. Then the Euler equation tells us that $c_t = c_s = c \; \forall \; t, s$.

In this case, optimal consumption will be given by:

$$
\begin{aligned}
c(l_1) &= \frac{1 - \frac{1}{1+r}}{1 - \left(\frac{1}{1+r}\right)^T} LY(l_1) \\
&= \frac{1}{\rho} LY(l_1)
\end{aligned}
$$

where $\rho \equiv \frac{1 - \left(\frac{1}{1+r}\right)^T}{1 - \frac{1}{1+r}}$. This implies that the optimised values are:

$$
\begin{aligned}
V(l_1) &= \sum_{t=1}^{T} \beta^{t-1} u(c(l_1)) - v(l_1) \\
&= \sum_{t=1}^{T} \left(\frac{1}{1+r}\right)^{t-1} u(c(l_1)) - v(l_1) \\
&= \rho u(c(l_1)) - v(l_1)
\end{aligned}
$$

The choice of l_1 will then depend on the sign of $V(1) - V(0)$, i.e. whether:

$$
\rho u\big(c(1)\big) - \rho u(c(0)) \; \lessgtr \; v(1)
$$

assuming $v(0) = 0$. Taking a first order Taylor approximation of $u(c(1))$ around $c(0)$ gives:

$$
u(c(1)) \; \approx \; u\big(c(0)\big) + u'(c(0))[c(1) - c(0)]
$$

Substituting this into the previous equation gives:

$$\rho u'(c(0))[c(1) - c(0)] \quad \lessgtr \quad v(1)$$

Now we can substitute in using the solution for optimal consumption:

$$u'(c(0))[LY(1) - LY(0)] \quad \lessgtr \quad v(1)$$

Or:

$$u'(c(0))\Delta LY \quad \lessgtr \quad v(1)$$

So the incentive to work depends on the product of the marginal utility of consumption and the increment to lifetime income from working relative to the period-1 cost of working.

We now distinguish between the case where the individual faces a tax and transfer system and where the individual does not. Denote the solution with a tax and transfer system by τ superscripts and the solution without a tax and transfer system with 0 superscripts.

Holding $v(1)$ fixed, the incentive to work in the presence of the tax and transfer system then depends on the size of:

$$u'(c^\tau(0))\Delta LY^\tau$$

And the incentive to work in the absence of the tax and transfer system depends on:

$$u'(c^0(0))\Delta LY^0$$

From here it is a short step to our lifetime work incentive measures. The FLRR can be written

as:

$$FLRR = \frac{Y^\tau(0)}{Y^\tau(0) + \Delta LY^\tau} = \frac{1}{1 + \frac{\Delta LY^\tau}{Y^\tau(0)}}$$

where $Y(l_1)$ is period-1 income. So the FLRR is one plus the financial payoff to work, ΔLY^τ,

normalised by period-1 out-of-work income, $Y(0)$, and inverted for comparability with the

static RR.

For the FLPTR, note that we can write the change in the incentive to work with and without

the tax and transfer system as:

$$u'(c^0(0))\Delta LY^0 - u'(c^\tau(0))\Delta LY^\tau \quad = \quad u'(c^0(0))[\Delta LY^0 - \Delta LY^\tau] + [u'(c^0(0)) - u'(c^\tau(0))]\Delta LY^\tau$$

where the first term on the RHS reflects the effect of the change in lifetime income on utility

while the second term reflects the change in marginal utility due to different consumption

levels.

The FLPTR can be written as:

$$FLPTR = \frac{\Delta LY^0 - \Delta LY^\tau}{\Delta LY^0}$$

The FLPTR is then just the first term in the equation above normalised by ΔLY^0. It measures

the change in the incentive to work as a result of the tax and transfer system ignoring the

wealth effect.