How taxes and welfare benefits affect work incentives: a lifecycle perspective

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Abstract: Personal taxes and benefits affect the incentive to work over the lifecycle by altering income-age profiles, insuring against adverse shocks, and changing the returns to human capital. In this paper, show how a lifecycle perspective alters our impression of how the UK tax and benefit system affects women's work incentives. Given that actual longitudinal data conflates age effects, cohort effects and policy effects, and, in the UK, is not available covering the full lifecycle, we use simulated data produced by a rich, dynamic structural model of female labour supply and human capital that incorporates family formation and fertility. We find that individuals experience considerable variability in work incentives across life that outweighs the variability across individuals. Changes in the presence of children and a partner, as well as the level of any partner's earnings, are key to explaining these patterns: work incentives vary dramatically depending on family composition and the earnings of any partner, especially for the lower-skilled – with women's own earnings explaining less than a seventh of the variation in work incentives – and most women experience a number of different family types during the course of their lives.

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Policy points:

- Most past policy work investigating the impact of taxes and benefits on financial work incentives has excluded any dynamic considerations
- We show that individuals experience considerable variability in financial work incentives across the lifecourse. This variation is due to changes in family composition and the earnings of any partner, especially for the lower-skilled. In aggregate, this variation is more significant than the variability across individuals.
- We suggest that future analyses at least take account of how incentives vary with age, and that future analyses of incentives by family type show an awareness that family type is not a fixed attribute of individuals.

1. Introduction

A crucial input to any assessment of a personal tax and benefit system is an analysis of how taxes and benefits affect individuals' financial incentives to work and earn more. Personal taxes and benefits affect incentives to work and earn more over the lifecycle by altering income-age profiles, insuring against adverse shocks, and changing the returns to human capital. Most previous work (summarised in Section 2) investigating the impact of taxes and benefits on financial work incentives has tended to exclude any dynamic considerations: few papers break results down by age group, let alone think about how work incentives change over time for an individual. This paper begins to fill this gap by examining how the UK's tax and benefit system affects the financial work incentives facing women, how these work incentives change over the lifecycle, and how they depend on lifecycle circumstances.

An understanding of work incentives that goes beyond the standard static analysis requires longitudinal data. This paper makes use of simulated lifecycle data produced by a structural, dynamic model of female labour supply and human capital accumulation that embeds a detailed characterisation of UK taxes and benefits, and whose parameters have been estimated so as to create lifecycle profiles that match UK household panel data. We use the model developed by Blundell et al. (2013); see also Blundell et al. (2016). The model is a standard lifecycle consumption and labour supply model, in the style of Eckstein and Wolpin (1989), Eckstein et al. (1999), Keane and Wolpin (1997) and Adda et al. (2007), but with additional features that make it suitable to assess the impact of taxes and benefits on work incentives and decisions over time, such as evolving family composition, a rich characterisation of the tax and benefit system, endogenous education choice, and experience accumulation. To our knowledge, this is the first tool capable of supporting the study of dynamic features of tax and benefit design taking into account labour supply responses, saving and skill formation.[2]

Using simulated data has a number of advantages relative to using observed panel data. The first is practical: it enables us to analyse complete lifecycles. Using panel data, we would be limited to half a full working life at most: the UK's longest-running UK panel dataset (the British Household Panel Survey and its successor) has only existed since 1991, and only a small fraction of the sample has been interviewed in every wave. Second, we can model cleanly the effect of a single tax and benefit system throughout life, allowing individuals to behave as they would under a constant policy regime, and can do so having stripped out time and cohort effects; by contrast, patterns observed in panel data will be confounded by changes in taxes and benefits over time, as well as time and cohort effects.

With these simulated data, we provide a descriptive analysis of women's financial work incentives under the UK personal tax and benefit system of 2012-13, given women's (simulated) optimal labour supply decisions.[3] As we explain further in section 3, the UK combines a relatively simple, individually-based, income tax system with a relatively complicated, family-based, set of cash benefits and refundable tax credits, where maximum entitlements are strongly influenced by family circumstances and there is a heavy reliance on means-testing against the joint family income. We measure work incentives using the marginal effective tax rate (METR), and the participation tax rate (PTR, equivalent to the average net tax rate paid on earnings when moving into work).[4]

We show that there is considerable variation in these measures of work incentives by family circumstances. For example, lone mothers have the highest METRs, but have PTRs that are relatively

[2] Chan (2013) presents a dynamic model of labour supply and program participation that reflects fully how welfare programmes and in-work tax credits affect the budget constraints faced by low-income workers in the US. Although the model incorporates the dynamic impact of time-limits in welfare, it lacks other important mechanisms that create dynamic links (such as human capital accumulation and saving); it also abstracts from changes in family circumstances.

[3] In a companion paper (Brewer, Costa Dias and Shaw, 2012), we use the same model to take a lifecycle approach to examining by how much the UK tax and benefit system redistributes income from rich to poor.

[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 the METR for workers and the PTR for non-workers (see p548).

low; these facts reflect both the nature of the tax and benefit system affecting lone parents, but also their simulated optimal labour supply choices given this tax and benefit system. For example, low-wage lone parents are generally entitled to generous (refundable) in-work tax credits, which act to reduce PTRs but which are means-tested, thus increasing METRs. Furthermore, the combination of a desire to work less in the presence of children, and the incentives produced by the withdrawal of tax credits, lead a considerable fraction of lone mothers to choose part-time work. Women in childless couples generally enjoy the strongest work incentives; this reflects the fact that such women are unlikely to be entitled to refundable in-work tax credits, as these are focused on families with children, and also unlikely to be entitled to welfare benefits were they not to work, because most of their partners are working, and that most choose to work full-time.

However, family circumstances do not stay constant throughout a woman's lifetime, and this emphasises the importance of analysing work incentives over the lifecycle. We find that there are striking changes in the number of women in work who face very high METRs, with the 75th percentile of METRs rising by over 0.2 between ages 20 and 40, before falling back again. The PTR, however, falls slightly with age and becomes less dispersed. We show that these lifecycle patterns are more pronounced for women with a low education.

The main novelty in our analysis is the ability to take a true longitudinal perspective, and this shows that there is a great deal of change in these incentive measures for individual women, with two-thirds of the variability across the population in METRs and PTRs being due to differences across the life-cycle rather than differences between individuals. This means that women tend not to be stuck permanently with weak work incentives. For example, less than 30 per cent of women aged 25–29 with a PTR exceeding 80% still have a PTR that high 10 years later. A lot of this change is due to changes in family circumstances, so the extent of change in the incentive measures tends to decline as women age because family circumstances change less often. The implications are that the work incentives currently facing a woman, given her family circumstances, may not be the ones that are relevant for large parts of her life. For example, women who (say) are currently facing low METRs because they have a high earner partner and do not have dependent children may well be affected by weak work incentives in the future if family circumstances change. On the other hand, it is, of course, not immediately obvious what are the implications of any given lifecycle pattern in work incentive measures for an individual's labour supply behaviour. In the dynamic structural model that is used to produce the underlying synthetic behaviour, individuals are assumed to make labour supply and consumption choices bearing in mind the entire life-cycle profile of current and future returns to current labour supply and how it is taxed; it is not clear that the way this affects current labour supply will be captured well by the lifecycle distribution of point-in-time work incentive measures.[5] However, policy makers and analysts continue to analyse the point-in-time work incentive measures, and our analysis at least provides a descriptive assessment of how these work incentives change over the lifecycle, and how they depend on lifecycle circumstances.

The rest of the paper is arranged as follows. In Section 2, we discuss the previous literature examining how taxes and benefits affect work incentives, and give a brief account of how we create various measures of financial work incentives using the dynamic, structural model. Section 3 gives an overview of the UK tax and benefit system for working-age adults, with a focus on how it affects financial work incentives. Section 4 analyses measures of financial work incentives across women who face the 2012-13 UK tax and benefit system, first across the population as a whole, but then with a lifecycle and a longitudinal perspective. Section 5 concludes. In appendices, we provide further details on the UK tax and benefit system, further details of the structural model used to simulate the individuals' lifetimes, and some supplementary results.

2. Measuring work incentives using a structural, dynamic model of female labour supply

In this section, we discuss the previous literature examining how taxes and benefits affect work incentives, and give a brief account of how we create various measures of financial work incentives using the dynamic, structural model.

2.1 Previous literature assessing how taxes and benefits affect work incentives.

Previous work analysing how the UK tax and welfare system affects financial work incentives includes Adam et al. (2006), Adam and Browne (2010) and Brewer et al. (2010). The main focus of Adam et al. (2006) is how and why measures of financial work incentives in the UK changed between 1979 and the mid-2000s, but they also show how the distribution of financial work incentives (under the 2005 UK tax and welfare system) varies by family type. Adam and Browne (2010) update some of this analysis, showing (just) the CDF of work incentives measures (under the 2008 UK tax and welfare system) by family type and work status. Brewer et al. (2010) chart the (empirical) relationship between gross earnings and various measures of work incentives (METR and PTRs) separately for

[5] We are pursuing this in ongoing work, developing the notion of "forward-looking PTRs" introduced in Brewer et al. (2013).

adults in different family types and work statuses: this shows that, at high earnings, METRs and PTRs vary little by family circumstances, but can vary substantially (conditional on earnings) at low levels of pre-tax earnings. Equivalent work for the EU is Jara and Tumino (2013) (with earlier analysis in Immervoll and O'Donoghue (2002), Immervoll (2004), and Immervoll et al. (2007)) who focus on the cross-country differences in the cross-sectional distribution of work incentives. The OECD's regular analysis is based on specimen families (OECD, 2015). For the US, regular updates are provided by the Congressional Budget Office (see, for example, CBO (2015)) for both specimen families and a representative sample of workers, and by the Urban Institute (see, for example, Maag et al. (2012)). Mulligan (2013) gives a recent analysis of how the distribution of financial work incentives has changed since the Great Recession, and Ziliak (2007) does something similar for a longer time period for recipients of welfare programs (who are those that typically face the highest METRs). What is crucial for our analysis, though, is that all of these papers assess how the tax and welfare system affects financial work incentives in a static, cross-sectional sense: very few break down their results by age group (which would show, for example, whether work incentives tend to be stronger or weaker for older workers than younger workers), and none takes a longitudinal approach to analysing work incentives (which would show whether an individual's incentive to work gets stronger or weaker as she ages).

The two examples we know of that take a longitudinal approach to measuring financial work incentives are Evans and Williams (2009) and Evans and Eyre (2004). These papers take the "specimen families" approach to measuring work incentives, giving hypothetical families a hypothetical lifecycle (by specifying the time profile of family formation and fertility, and of how earnings and employment change as individuals age). Evans and his co-authors are thereby able to analyse how financial work incentives change for some specific families as they age. But there are weaknesses to the approach: the analysis is done only for a small handful of families, the measures of work incentives used are still static ones, and the lifecycle profiles are generated by the researcher with little link to individuals' actual behaviour.[6]

2.2 Measuring work incentives using a structural, dynamic model of female labour supply

[6] Evans and co-authors also focus on how the usual way in which tax thresholds and entitlements and earnings disregards in benefit and refundable tax credits are adjusted annually for price changes affects work incentives for a given family over time. We deliberately abstract from this issue: as explained in Section 3, our modelling assumes families face a given (real) tax and welfare system throughout their working lives.

A dynamic analysis of work incentives requires some sort of longitudinal data, and in this paper we use simulated data produced by a structural, dynamic model of female labour supply and human capital accumulation combined with an accurate UK tax and benefit calculator called FORTAX (see Shephard (2009) and Shaw (2011)). Using simulated data has a number of advantages relative to using observed panel data. The first is practical: it enables us to analyse complete lifecycles. Using panel data, we would be limited to half a full working life at most: the UK's longest-running UK panel dataset (the BHPS and its successor) has existed only since 1991, and only a small fraction of the sample has been interviewed in every wave. Second, we can model cleanly the effect of a single tax and benefit system throughout life, allowing individuals to behave as they would under that constant system, and can do so having stripped out time and cohort effects. In contrast, patterns observed in panel data will be confounded by changes in taxes and benefits over time – which, given that forward-looking individuals will in principle be responding to current and expected future policy regimes, would make it very difficult to relate observed behaviour to any given policy regime – as well as time and cohort effects.

Here we provide a brief account of the model we use to simulate women's lifetimes, and then discuss how we use the model to create various measures of financial work incentives. The model we use was developed and estimated in Blundell et al. (2013); see also Blundell et al. (2016). See there and Appendix C for more detail.

The model is a standard lifecycle consumption and labour supply model, in the style of Eckstein and Wolpin (1989) , Eckstein et al. (1999), Keane and Wolpin (1997) and Adda et al. (2008), but with additional features that make it suitable to assess the impact of taxes and benefits on work incentives and decisions over time. The focus of the model is women, as previous work has shown them to be more responsive to work incentives than men (see Meghir and Phillips, 2010, or Keane, 2011, for recent surveys). A woman's life is split into education, working life and retirement. At age 17, women choose between three levels of education: basic, intermediate and higher, corresponding to GCSEs or less, A-levels or post-compulsory vocational education, and university. The level of education determines the type of human capital a woman has to offer in the labour market, and the age at which she enters the labour market. After education, women enter the labour market and, in each year, they choose how much to work (zero, part time (20 hours per week) or full time (40 hours per week)) and save.[7] Family composition changes according to stochastic but exogenous processes

[7] These hours points have been chosen to reflect the bunching observed in the weekly hours worked by women. When estimating the model, women working between 1 and 20 hours were assigned to the 20 hours point, and women working more than 20 hours to the 40 hours point. This is obviously a simplification of the

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. Individuals are risk averse, and face uncertainty over future productivity and family composition but not over future tax and benefit systems. Insurance markets are incomplete, and partial self-insurance is possible through saving and the accumulation of human capital (education and experience). Individuals are unable to borrow except to fund education. This set-up means that the tax and benefit system may be of value to individuals both by providing insurance and by alleviating credit constraints.

In the model, women's work incentives are fully determined by the following factors:

- Female characteristics: age, hours of work and wage (which depends on her education, experience and productivity)
- Partner characteristics: presence of partner, hours of work and wage (which depends on the partner's education, the age of the woman (a proxy for the partner's age), and the productivity of the partner)
- Child characteristics: presence and age of children
- Family characteristics: the level of rent paid, and whether the family has to pay for childcare

The model is estimated on an unbalanced panel of around 4,200 women and their families taken from the British Household Panel Survey (BHPS) over 16 waves, 1991-2006. Estimation is performed using the method of simulated moments (MSM). Sections 6 to 8 of Blundell et al. (2016) show the implications of the model for labour supply elasticities, wages and employment, and how these vary over the lifecycle and with educational attainment (see, eg, Table XIV and Figure 9 for detail on labour supply elasticities). Blundell et al. (2016) also discusses in detail the full range of behavioural responses to certain policy reforms.

Having estimated 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

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distributon of working hours, but it matches well the pattern for women with children (see Beffy et al. (2016); data from the Annual Survey of Hours and Earnings suggest that women without children tend to work full time (i.e. around 40 hours on average). The main kink (or notch) in the actual budget constraint is located at 16 hours; there is a smaller notch at 30 hours.

the model (e.g. labour supply, consumption, assets, experience and education, plus the work incentive measures). When performing these simulations, we assume individuals face a single tax and benefit system throughout life: we use the UK system in existence in April 2012. This allows us to focus on the effects of a particular tax and benefit system, rather than worry about individuals being exposed to different tax and benefit systems at different stages of life. The model also effectively strips out cohort effects. This means the population we simulate is representative of actual women in the UK aged 16-18 some time over the period 1991 to 2006 but who then live their lives, and make utility-maximising choices about human capital, labour supply and consumption, under the 2012 tax and benefit system.

With the model, we then calculate two standard measures of work incentives: the marginal effective tax rate (METR), which describes what fraction of an incremental change to gross family earnings is lost by the family through increased tax liabilities and reduced benefit entitlements, and the participation tax rate (PTR), which describes what fraction of the change in gross earnings caused by one adult moving into work is lost by the family through increased tax liabilities and reduced benefit entitlements. We calculate the METR by increasing labour supply by one hour per week.[8] The METR has little practical relevance for those not working (because we observe essentially no one in the data working just one hour a week) and so we condition on being employed when calculating the METR at observed hours.[9] We calculate the PTR for workers at their observed hours, and calculate the PTR for non-working women having set hours equal to the number that they would have worked had they been employed, something we know because the model gives us a complete ranking for the different hours choices. We ignore consumption taxes and social insurance contributions made by employers, and we ignore the fact that payment of social insurance contributions may increase future entitlement to insurance benefits (see, e.g., Feldstein and Samwick, 1992). (Appendix B gives the full definitions and details of these calculations). Finally, Appendix C shows how well the distribution of work incentives produced by the model match those calculated from a cross-sectional data from a household survey.[10]

[8] We hold childcare spending fixed at its baseline level so that the METR we calculate reflects only the impact of the tax and benefit system on our measures of work incentives.

[9] The OECD take a similar approach: "In all except one case, the marginal tax rates are calculated by considering the impact of a small increase in gross earnings on personal income tax, social security contributions and cash benefits. The exception is the case of a non-working spouse where the move from zero to a small positive income is unrepresentative of income changes and therefore of little interest. So, for this case, the marginal rates for the spouse are calculated by considering the impact of an income increase from zero to 33% of the average wage" (OECD, 2015, p548).

[10] In most household surveys in the UK, "income" is measured over at a high frequency, such as a week or a month. We follow that tradition here, and so our measures of work incentives should be thought of as short-

The model's focus on the dynamic implications of human capital choices and labour supply choices mean that some simplifications are made when modelling other processes. For example, and as detailed in Appendix C, the earnings and labour supply of any male partners both follow a simple and exogenous process; family formation and dissolution, and fertility, both depend on women's education, but are otherwise exogenous. The demand for childcare is given by a family's working patterns, and the price is exogenous. Finally, although the model allows for saving, housing tenure is fixed across people's lives. Appendix C presents some validation results (looking at the distribution of financial work incentives), and other information is presented in Blundell et al. (2013).

An alternative approach would be to use data generated by the non-behavioural dynamic microsimulation model put forward in Levell et al. (2015). The analysis in that paper is based on simulated longitudinal data that was estimated and calibrated so that it was representative of the actual experiences of the baby-boom cohort (born 1945–54) under the differing tax and benefit systems they were actually exposed to as they aged. In contrast, we consider behaviour under a single tax and benefit system, allowing us to draw cleaner conclusions about work incentives given optimal behaviour under that system.

3. An overview of the UK tax and benefit system

This section gives an overview of the tax and benefit system in the UK (as of April 2012) with a focus on the features of the system that are relevant given our concern over how the system affects work incentives. This consideration means we examine only the working-age population, and ignore issues relating to income from self-employment and unearned income. There is more detail is in Appendix A; see also Hood and Oakley (2014) and Pope and Roantree (2014).

Overall, the UK combines a relatively simple, individual-based, income tax system with a relatively complicated, family-based set of cash benefits and refundable tax credits in which maximum entitlements are strongly influenced by family circumstances and there is a heavy reliance on means-testing. Table 1 compares the yield of the main two taxes, and the expenditure on and recipients of the 5 main welfare programmes and tax credits.

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run, because we ignore time-limits that apply to a few welfare benefits (and see Bartels and Pestel (2016) for an assessment of how this can affect measures of the financial gain to work). On the other hand, we also ignore the disregards in the tax credit system that in practice mean that tax credits may not respond in the short-run to changes in earnings.

The two main personal taxes on earnings are *income tax* and *National Insurance*, both of which are assessed at the individual level. In practice, these two can be thought of as being the same tax that together produce a progressive rate schedule with a combined marginal effective tax rate that rises from 0% on earnings below £146 a week (£7,592 a year) to 52% on earnings above £150,000 a year. The most common combined METR, which applies to those whose earnings lie between £8,105 and £42,475 (approximately the 5th and 85th quantiles in the distribution of earnings) is 32%.

Most of the key cash benefits and refundable tax credits in the UK are means-tested and assessed against family income, where a family is defined as an adult plus any spouse or cohabiting partner. (*Child benefit* was not means-tested in the period we study, but became means-tested from January 2013). The cash benefits and refundable tax credits can be thought of as forming two groups: those designed to replace, or top-up, earnings, and those designed to compensate for different needs.

The group designed to replace, or top-up, earnings consists of *Income Support*,(IS) income-based *Jobseeker's Allowance* (hereafter JSA; our model ignores the small contributory-based form of *Jobseeker's Allowance*), *Employment and Support Allowance* (ESA) which we abstract from in our model and *Working Tax Credit* (WTC). The eligibility conditions have been designed so that families are entitled to at most one: IS, JSA and ESA are intended as income top-ups for families where no one is in paid work, and WTC is designed to provide an income top-up for families where someone is in paid work (to receive WTC, a family with dependent children must have one parent working 16 hours or more a week, couples with children must also together work a total of 24 hours or more a week, and, in families without children, at least one adult must work 30 or more hours a week and be aged 25 or over). Maximum entitlements to all these benefits depend upon family circumstances, being (mostly) higher for couples than single adults.

The group designed to compensate families for particular needs include *Child Tax Credit*, *Housing Benefit* (including *Local Housing Allowance*) and *Council Tax Benefit*. All are means-tested against family income, but do not depend directly on whether the family is engaged in paid work. As explained in Appendix A, the maximum entitlement to these benefits depends on the number and presence of children, whether the household is renting or not (and, if so, the amount of rent paid), and the liability to the local property tax, known as *Council Tax*.

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. Figures 1 and 2 show budget constraints, METRs and PTRs for a number of specimen families. They highlight three things.

First, the interaction between the income-replacement benefits and the in-work tax refundable credits leads to non-convex budget constraints for those on a low wage, with a workers facing a 100% METR (through the withdrawal of income-replacement benefits) on work of around 0 to 10 hours/wk, but then a discontinuous jump in net family income at 16 hours/wk and again at 30 hours/wk (these correspond to entitlement (or increased entitlement) to WTC).

Second, the workers that face the highest METRs are not those on very high earnings, but those in low-income families that face multiple withdrawal of means-tested cash benefits or refundable tax credits: the METR on earnings faced by those on the highest levels of earnings is 52%, but those subject to a withdrawal of *child tax credit* or *working tax credit* as well as liability to *income tax* face a METR of 73%, and those also facing a withdrawal of HB or CTB will face a METR in excess of 90%.

Third, METRs and PTRs vary considerably by family type. For example, the relatively generous in-work refundable tax credits for lone mothers mean that PTRs can be very low just above 16 hours of work/wk at a low wage. However, the right-hand panel of Figure 1 shows that some lone mothers in work will face high METRs, caused by withdrawal of *Housing Benefit* on top of *child tax credit* or *working tax credit*. The middle panel of Figure 2 shows that a stylised low-wage adult in a couple with children experiences both high METRs and high PTRs, but that the stylised individual in a couple without children (left panel), and the stylised high-wage woman in a couple with children, have relatively low METRs and PTRs.

4. How does the UK tax and benefit system affect work incentives: cross-sectional, lifecycle and longitudinal perspectives

This section provides our core descriptive analysis of women's financial work incentives under the UK personal tax and benefit system of 2012-13, given women's (simulated) optimal labour supply decisions, and taking a lifecycle perspective. The analysis is in three stages. First, we show how work incentives vary across the population, with a focus on how they are different for women in different family circumstances. Second, we show work incentives change in aggregate over the lifecycle, and how these changes relate to lifecycle circumstances. Both these analyses could be done with standard cross-sectional data from household surveys, but the use of simulated data here means that we can remove cohort effects from the analysis and impose a constant policy regime. Finally, we go on to something not possible with standard cross-sectional data from household surveys, and examine how work incentives change longitudinally for individual women. We remind the reader the observed patterns are driven in part by variation in tax rates across family composition and in part by differences in labour supply across family composition: we are providing a descriptive analysis of the incentives that women would actually face given their optimal responses to the given tax and benefit regime.

4.1 Cross-sectional analysis

Figure 3 plots cumulative distributions for the METR (conditional on working) and PTR (mass points in the METR distribution mean that probability densities cannot easily be drawn). A striking feature is the fact that more than 70 per cent of working women have an METR of 32%. Table 2 shows which taxes and benefits are responsible, on average, for different ranges of METRs. The modal rate of 32% is made up of the standard rate of *income tax* (0.20) plus *National Insurance* (0.12). Table 2 also shows that weak work incentives (a METR in excess of 0.6) tend to arise because of the payment of income tax and National Insurance as well as withdrawal of *working tax credit, child tax credit* and *housing benefit*, and, unsurprisingly, that the lowest METRs arise for women who are not liable to *income tax* or facing a withdrawal of the key means-tested cash benefits. Finally, the table shows the mean earnings of workers in each band, revealing the typical U-shape of METRs against earnings.

Figure 3 shows that the distribution of PTRs is much smoother than that of METRs, and Table 3 shows that almost 70 per cent of women have a PTR between 0.2 and 0.6, the key components of which are payments of *income tax* and *National Insurance* plus the *loss of income support,* and, to a lesser extent, the withdrawal of *child tax credit* and *council tax benefit*. Individuals with relatively strong incentives to work (low PTRs) typically have a *working tax credit* award that offsets the loss of *income support* when moving into work. Those with weak incentives to work, with PTRs in excess of 0.8, are largely those facing a withdrawal of *housing benefit* and *income support* that is not offset by an entitlement to in-work tax credits, and these will mostly be women without children.

Figure 4 shows how work incentives differ by family type, classifying women into one of single adults without children, adults in couples without children, lone mothers, and adults in couples with children. There are clear differences by family type. Lone mothers have the highest METRs, with three quarters facing an METR over 0.4, reflecting the large amount of means-tested support targeted towards them. However, PTRs for this group are relatively low, because of the generous work-contingent *Working Tax Credit*. Women in couples without children generally enjoy the strongest work incentives: over 90 per cent have METRs of 0.32 or less, and over three quarters have a PTR under 0.30. These arise because in-work support in the UK – the withdrawal of which contributes to high METRs amongst workers – is focused towards families with children, and because women with partners but no children are unlikely to be entitled to cash benefits were they not to work – entitlement to which can lead to high PTRs – because most have partners who are themselves in work. Almost all childless single women have PTRs of at least 0.40, a consequence of the loss of *Income Support* on moving into work which is only sometimes offset by entitlement to WTC in work, and the liability to *income tax* and *National Insurance*. These differences reflect both differences in how the UK tax and benefit system treats different sorts of mothers, but also the different choices made by women at different stages of their lifecycle who are also facing different patterns of work incentives because of the tax and benefit system.

Figure 5 shows differences in work incentives by education. Of course, education has no direct impact on tax liabilities and entitlements to cash benefits; instead, any differences are due to differences in employment, wages and family circumstances between education groups. Women with low levels of education are more likely to have METRs above 0.4 than better-educated women, but are also more likely to have very *low* PTRs. Both reflect that women in the low education group tend to be less well paid and more likely to be lone mothers; as Figures 1 and 2 showed, lone mothers tend to face reasonably strong incentives to do some work (low PTRs), but relatively weak incentives to work more (high METRs amongst workers) due to withdrawal of refundable tax credits and cash benefits.

4.2 Changes over the lifecycle

The previous sub-section showed the considerable variation in incentives across the population, and that a large amount of the variation relates to family circumstances. But, given that family circumstances also vary considerably across the lifecycle, we show in this sub-section how the cross-sectional differences by family type and education translate into patterns by age, something that has not been drawn out by the previous literature.

Figure 6 plots the mean and various quantiles of the METR for employed women by age in the left panel, and how family type changes by age in the right panel. Although the 10th, 25th, 50th and 75th percentiles of the distribution of METRs remain constant at 0.32 throughout life (corresponding, as we saw in section 4.1, to women paying basic-rate *income tax* and *National Insurance*), there are substantial changes in the right tail as individuals age, with the mean METR rising by around 0.05 between the ages of 20 and 40, and the 90th percentile rising by 0.3 or 0.4. The right panel in Figure 6 shows that this coincides with a large rise in the share of families with children; as we saw in Figure 4, women with children (particularly lone mothers) generally have higher METRs than those without. (Because we show METRs for working women only, differential selection into paid employment over time may explain some of the lifecycle variation in these graphs.)

Clear lifecycle patterns also emerge for the PTR. The left panel of Figure 7 shows that there is a slight downward trend and a narrowing of the distribution over the lifecycle, both of which are consistent with wages increasing with age (due to experience effects; there is no secular wage growth in the model). The relationship between changes in PTRs and changes in family type (shown in the right panel of Figure 7) is less apparent than it is for METRs in Figure 6, consistent with the finding from Section 4.1 (and Figure 4 in particular) that women in families with children do not uniformly have higher or lower PTRs than those without children.

These aggregate changes by age hide considerable variation by education.[11] Figure 8 shows that the dispersion of the METR for the high education group is much less marked than it is for the low education group: the 75th percentile of the METR for the high education group remains at 0.32 throughout working life, but peaks at over 0.5 for those in the low education group. It is also the case that the high educated group have substantially lower dispersion in their PTRs throughout the lifecycle than the low educated group; but there is somewhat less of a downward trend (see Figure 9).

To explore more the differences between family types, Figures 10 and 11 repeat this analysis of how METRs and PTRs change by age, but conditional on women being in a specific family type. Of course, this analysis now cannot be interpreted as a true lifecycle analysis because it is affected by compositional changes as women age (e.g., the set of 20-year-old lone mothers are likely to be different from the set of 40-year-old lone mothers). Instead, we interpret the Figures as showing the differences between older and younger women of a given family type. For example, Figure 10 shows there is little difference between the distribution of METRs for younger and older women who do not have children. However, among women with children, the general pattern is for METRs to be lower where the mother is older. This presumably reflects that the older women have higher wages,

[11] Appendix Figure D.2 shows the analysis by age and potential lifetime earnings quartile, which is obviously highly correlated with education and thus reveals similar patterns.

as well as partners with higher wages, reducing entitlement to means-tested refundable tax credits which would otherwise lead to high METRs.

As with METRs, there is also little difference between the distribution of PTRs amongst younger and older women without children (see Figure 11). Amongst those with children, older lone mothers tend to have higher PTRs than younger ones, and older mothers in couples tend to have lower PTRs than younger ones. These differences seem likely to be due to a combination of compositional changes, and lifecycle changes in labour supply and hourly wages. The compositional changes arise because older mothers tend to be more highly educated than younger mothers (as higher educated women tend to have children later than low educated women). The lifecycle changes arise because returns to experience mean that older women tend to earn more than younger women (as would these women's partners, if they have any). For mothers with a partner, higher-earning partners reduce the likelihood that the family would be entitled to any refundable tax credits if the women did not work, hence lowering the women's out-of-work income, and thus their PTRs. For lone mothers, higher wages will reduce their entitlement to refundable in-work tax credits when in work, and move them on to higher tax rates, raising PTRs but having an ambiguous impact on METRs.

Figure 12 underlines the role that the presence of children has on financial work incentives by showing the distribution of METRs and PTRs by age where women have been classified by a time-invariant classification of family type. Amongst those who are never parents, the 90:10 range of METRs is contained between 32% and 42% for almost all of working life, with no bulge upwards in METRs during these women's 30s and 40s; also, the distribution of PTRs is more compressed than that of women who do have children, with never-parents seeming not to face the very weak or very strong incentives to work (and Appendix Figure D.1 shows an expanded variant on this).

In summary, cross-sectional differences in work incentives by family circumstances (primarily family type and earnings) combined with changes in family structure and wages as women age translate into substantial variation across the lifecycle. The main child-rearing years see a large rise in the number of women facing very high METRs, whereas there is a slight downward trend and narrowing of the distribution of PTRs with age, consistent with wages increasing with accumulated experience.

An interesting question is the extent to which there is a correlation between work incentives and labour supply elasticities across the life: do taxes and benefits reduce the return to work more at ages when women's labour supply is most responsive to changes in wages? The answer is mixed. Blundell et al. (2016) present labour supply elasticities calculated using the same model as we use here. They highlight three main findings. First, they show that elasticities vary with age. peaking around the early 30s – which is when family formation and child-rearing are most important. Relating this to our results, we see that women tend to face higher METRs at ages when their labour supply is most elastic. The pattern for PTRs is less clear. Second, towards the end of working life, Blundell et al. show that elasticities (particularly Marshallian elasticities) tend to increase with age. We find that PTRs (and to some extent METRs) decline slightly with age, implying that taxes and benefits reduce the return to work more when labour supply is less responsive. Third, Blundell et al. find that elasticities are always higher for those with basic education than those with higher education. We show that women with basic education experience higher average values of METRs, and greater dispersion of METRs and PTRs, than women with higher education. Thus, for METRs at least, weaker work incentives do tend to coincide with greater sensitivity to wage changes.[12]

4.3 A longitudinal analysis

So far we have considered how the distribution of work incentives varies with age across a population of women, without considering how persistent (or not) they are over time for any given individual. This is an important issue, since the policy implications may be quite different if individuals face widely varying PTRs from period to period than if the same individuals experience high PTRs throughout life.

Table 4 shows the results of a simple decomposition of the variance of the METR and PTR (measured across all the women in all the years of working-life in the model for PTRs, and the same but conditional on being in work for METRs) into "between" (i.e. across individual) and "within" (i.e. across the lifecycle) components. Two thirds of the METR and PTR variances are explained by the within (across the lifecycle) component, confirming that individuals experience considerable variability in work incentives across their lives. Nevertheless, the difference in work incentives for two randomly-drawn women of two randomly-selected ages is expected to be around 50% higher than the difference for the same woman in two randomly-selected ages.

[12] However, we would not want to push this analysis too far. The pattern of work incentives that we analyse are those faced by women given their optimal responses to the given policy regime. And it is not immediately obvious what are the implications of any given lifecycle pattern in work incentive measures for an individual's labour supply behaviour as, in the dynamic structural model that is used to produce the underlying synthetic behaviour, individuals are assumed to make labour supply and consumption choices bearing in mind the entire life-cycle profile of current and future returns to current labour supply and how it is taxed; it is not clear that the way this affects current labour supply will be captured well by the lifecycle distribution of point-in-time work incentive measures. To assess directly whether tax reforms at different ages would have different impacts on labour supply, then one would need to use the model directly to assess alternative policies, as is done in Blundell et al. (2016).

To get a feel for how this translates into persistence in work incentives across the lifecycle, Tables 5 and 6 present transition matrices across the METR and PTR distributions. We take women aged 25-29 in the base year and consider four different horizons: one, five, 10 and 20 years. In both cases, the tables show a high degree of persistence for one-year transitions and a decline in persistence as the horizon lengthens, which is particularly noticeable for high METRs. In general, this means that women tend not to be stuck permanently with weak work incentives. For example, less than 30 per cent of women aged 25–29 with a PTR exceeding 0.8 still have a PTR that high 10 years later.

Tables 7 and 8 show how these patterns evolve with age, based on five-year transitions. Table 8 shows that, for all but the highest PTRs, persistence in PTRs (measured by the proportion on the leading diagonal) increases with age. The patterns are a little less clear for METRs (Table 7), partly because there is such a high concentration of individuals with METRs between 0.2 and 0.4.

We attribute the increasing persistence in PTRs as women age to two factors. First, results in Section 4.2 suggest that a lot of the changes in PTRs will be due to changes in family circumstances. Table 9 therefore shows the 5-year transition rates between the 4 family types. The two family types without dependent children see a fall in the likelihood of a family transition as women age, and the two family types with dependent children see a change in the most likely form of family change as women age (for example, the 5-year transition rate out of lone motherhood is between 34% and 40%, but, at age 25, the only other destination is to be in a couple with children, whereas, at age 45, the majority of those leaving lone motherhood enter a family type with no dependent children). Second, it is also the case that the (estimated) experience profiles flatten out as women age, meaning that wages grow more slowly and so women are less likely to move into different tax brackets.

5. Summary and conclusions

Personal taxes and benefits affect incentives to work and earn more over the lifecycle by altering income-age profiles, insuring against adverse shocks, and changing the returns to human capital. Most previous work investigating the impact of taxes and benefits on financial work incentives has tended to exclude any dynamic considerations: few papers break results down by age group let alone think about how work incentives change over time for an individual, and the measure of financial work incentives used is always a static one (in the sense of ignoring future returns from working today).

This paper has taken a first step towards filling this gap in the literature by using simulated data produced by a dynamic structural model of female labour supply and human capital to show how a lifecycle perspective alters our impression of the effect of the UK tax and benefit system on the financial work incentives facing women. We have analysed in detail the way that the UK tax and benefit system of April 2012 affects women's work incentives, were they to spend their working lives under this constant policy regime. The UK system is characterised by individual-level income taxes, along with generous cash benefits or refundable tax credits that are contingent on children, or those who rent, and which are means-tested against the joint income of a couple.

Our analysis of the usual static measures of work incentives under the 2012 UK tax and benefit system confirmed that there is considerable variation by family circumstances. For example, lone mothers have the highest METRs, but have PTRs that are relatively low; these are both due to the large amount of in-work support targeted towards lone mothers, something that lowers PTRs but increases METRs, as it is means-tested. In contrast, women in couples without children generally enjoy the strongest work incentives. This is because in-work support (the withdrawal of which contributes to high METRs) is focused towards families with children in the UK, and because women in couples without children are unlikely to be entitled to out-of-work welfare benefits were they not to work (because most of their partners are working), giving them low PTRs.

Family circumstances do not stay constant throughout a woman's lifetime, and this emphasises the importance of analysing work incentives by age. We found that there are large changes in the number of women in work facing very high METRs: the mean METR rises by around 0.05, and the 90^{th} percentile by 0.3 or 0.4 between the ages of 20 and 40. These changes coincide with a large increase in the share of families with children. For the PTR, there is a slight downward trend and narrowing of the distribution with age, both of which are consistent with earnings increasing with accumulated experience.

From a longitudinal perspective, there is a great deal of change in work incentives for individual women, with two-thirds of the variability in METRs and PTRs being due to differences across the life-cycle rather than differences between individuals. This means that women tend not to be stuck permanently with weak work incentives. For example, less than 30 per cent of women aged 25–29 with a PTR exceeding 80% still have a PTR that high 10 years later. A lot of this change is due to changes in family circumstances, so the extent of change tends to decline as women age because family circumstances change less often.

The direct policy implications are subtle. We show that higher METRs (and so weaker work incentives) do coincide with women's greater sensitivity to wage changes, although there is less of a correlation with PTRs. However, forward-looking individuals make decisions about current labour supply and consumption choices bearing in mind their future life-cycle profile of returns to current labour supply and how it is taxed, and so it would be too simplistic to say that this provides an additional reason to seek to lower those high METRs. However, the extent of changes over an individual's lifecycle is a reminder of the limitations of static, point-in-time analyses: the incentives currently facing a woman, given her family circumstances, may not be the ones that are relevant for large parts of her life. For example, analysis that conditions on family type (such as analysing work incentives for lone mothers) downplays the fact that lone mothers are not always lone mothers; conversely, the high METRs facing lone mothers will affect a higher fraction of women over their lifetime than at a point in time. We therefore hope that we have moved the analysis of how taxes and benefits affect decisions to work and earn more to be more in line with the literature on how individuals take a dynamic perspective when making those same decisions to work and earn more.

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Tables

Table 1: Revenue from main personal taxes and expenditure on main welfare and tax credit programmes, 2015-16.

	Revenue (£bn)	As share of total tax revenues	Expenditure (£bn)	As share of total expenditure on welfare and tax credits	Recipients (m)
Personal taxes					
Income tax	169.8	0.249			
National insurance	114.9	0.169			
Income-related credits and means-tested welfare benefits					
Working tax credit			5.9	0.028	2.4
Child tax credit			21.7	0.103	3.9
Income support			5.0	0.024	1.4
Housing benefit			24.3	0.115	4.8
Council tax benefit			4.9	0.024	5.9

Sources: Table 4.6 in http://budgetresponsibility.org.uk/download/economic-and-fiscal-outlook-march-2016/, and Table 3.1 in https://www.ifs.org.uk/bns/bn13.pdf

Table 2. Mean composition of METR by METR band for working women

	≤0.2	(0.2,0.4]	(0.4,0.6]	(0.6,0.8]	>0.8	All
Personal taxes						
Income tax	0.002	0.200	0.257	0.194	0.136	0.193
National insurance	0.017	0.120	0.031	0.120	0.087	0.108
Income-related credits and means-tested welfare benefits						
Working tax credit	0.000	0.000	0.083	0.287	0.235	0.037
Child tax credit	0.000	0.000	0.045	0.121	0.017	0.016
Income support	0.000	0.000	0.000	0.000	0.000	0.000
Housing benefit	0.000	0.000	0.000	0.001	0.327	0.001
Council tax benefit	0.021	0.000	0.024	0.013	0.084	0.005
Other	0.000	0.000	0.000	0.000	0.039	0.000
Total	0.039	0.320	0.441	0.736	0.924	0.360
Woman's mean gross earnings (£ per year)	6,098	22,281	32,497	13,441	9,271	21,271
Share of individuals	0.051	0.767	0.076	0.103	0.004	1.000

Notes: The notation $(x, y]$ in the column headings means greater than x and less than or equal to y. Authors' calculations based on simulated data.

Table 3. Mean composition of PTR by PTR band for all women

	≤0.2	(0.2,0.4]	(0.4,0.6]	(0.6,0.8]	>0.8	All
Personal taxes						
Income tax	0.040	0.120	0.087	0.067	0.002	0.084
National insurance	0.027	0.073	0.054	0.044	0.002	0.052
Income-related credits and means-tested welfare benefits						
Working tax credit	-0.148	-0.032	0.029	0.006	0.018	-0.035
Child tax credit	0.005	0.027	0.060	0.017	0.000	0.031
Income support	0.145	0.084	0.162	0.326	0.854	0.162
Housing benefit	0.001	0.006	0.019	0.165	0.112	0.022
Council tax benefit	0.015	0.019	0.049	0.054	0.035	0.030
Other	0.006	0.003	0.003	0.003	0.000	0.004
Total	0.092	0.300	0.464	0.684	1.024	0.350
Woman's mean gross earnings in work (£ per year)	10,120	25,606	17,424	13,758	5,492	18,106
Share of individuals	0.230	0.361	0.318	0.058	0.032	1.000

Notes: The notation $(x, y]$ in the column headings means greater than x and less than or equal to y. Authors' calculations based on simulated data.

Table 4. Decomposition of variance into between and within components

	METR (conditional on working)	PTR
Overall	0.023	0.047
Between	0.010	0.016
Within	0.016	0.031

Notes: components do not sum due to small sample correction, differing group sizes (because high education individuals enter the labour market later) and rounding. Authors' calculations based on simulated data.

Table 5. Transition matrix for METR bands for different horizons (individuals aged 25-29 in base year and employed in both years)

	1 year forward								5 years forward					
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**			**≤0.2**	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**
≤0.2	0.757	0.173	0.033	0.037	0.000	0.047		**≤0.2**	0.405	0.396	0.052	0.146	0.000	0.035
0.2-0.4	0.013	0.938	0.024	0.025	0.000	0.772		**0.2-0.4**	0.026	0.849	0.063	0.061	0.001	0.775
0.4-0.6	0.027	0.209	0.624	0.140	0.001	0.067		**0.4-0.6**	0.030	0.425	0.364	0.181	0.001	0.071
0.6-0.8	0.019	0.198	0.066	0.716	0.002	0.114		**0.6-0.8**	0.050	0.440	0.089	0.420	0.001	0.118
>0.8	0.039	0.519	0.039	0.269	0.135	0.001		**>0.8**	0.021	0.638	0.106	0.213	0.021	0.001
	10 years forward								**20 years forward**					
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**			**≤0.2**	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**
≤0.2	0.262	0.502	0.045	0.191	0.001	0.035		**≤0.2**	0.152	0.678	0.043	0.125	0.003	0.046
0.2-0.4	0.031	0.797	0.080	0.090	0.001	0.771		**0.2-0.4**	0.029	0.783	0.084	0.100	0.004	0.763
0.4-0.6	0.026	0.526	0.256	0.191	0.002	0.074		**0.4-0.6**	0.018	0.709	0.134	0.135	0.004	0.071
0.6-0.8	0.052	0.546	0.084	0.317	0.002	0.120		**0.6-0.8**	0.039	0.707	0.056	0.196	0.002	0.119
>0.8	0.020	0.706	0.039	0.196	0.039	0.001		**>0.8**	0.016	0.787	0.066	0.131	0.000	0.001

Notes: Conditional on working in both years under consideration. Authors' calculations based on simulated data.

Table 6. Transition matrix for PTR bands for different horizons (individuals aged 25-29 in base year)

	1 year forward								5 years forward					
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**			**≤0.2**	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**
≤0.2	0.823	0.112	0.043	0.010	0.011	0.219		**≤0.2**	0.612	0.198	0.135	0.027	0.028	0.219
0.2-0.4	0.074	0.796	0.120	0.009	0.003	0.320		**0.2-0.4**	0.140	0.586	0.233	0.033	0.008	0.320
0.4-0.6	0.038	0.122	0.812	0.023	0.005	0.368		**0.4-0.6**	0.125	0.264	0.553	0.042	0.015	0.368
0.6-0.8	0.046	0.055	0.145	0.697	0.058	0.051		**0.6-0.8**	0.128	0.160	0.256	0.389	0.068	0.051
>0.8	0.084	0.032	0.054	0.077	0.753	0.041		**>0.8**	0.227	0.104	0.151	0.101	0.418	0.041
	10 years forward								**20 years forward**					
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**			**≤0.2**	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**
≤0.2	0.522	0.230	0.181	0.035	0.032	0.219		**≤0.2**	0.395	0.308	0.235	0.037	0.025	0.219
0.2-0.4	0.171	0.508	0.266	0.044	0.011	0.320		**0.2-0.4**	0.169	0.494	0.282	0.044	0.011	0.320
0.4-0.6	0.177	0.309	0.443	0.052	0.019	0.368		**0.4-0.6**	0.198	0.394	0.350	0.046	0.013	0.368
0.6-0.8	0.166	0.220	0.281	0.276	0.057	0.051		**0.6-0.8**	0.190	0.296	0.250	0.211	0.053	0.051
>0.8	0.263	0.134	0.213	0.104	0.287	0.041		**>0.8**	0.282	0.195	0.220	0.129	0.173	0.041

Notes: Authors' calculations based on simulated data.

Table 7. 5-year transition matrix for METR bands at different ages (for individuals employed in both years)

	Age 25-29								Age 35-39					
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**			**≤0.2**	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**
≤0.2	0.405	0.396	0.052	0.146	0.000	0.035		**≤0.2**	0.362	0.541	0.017	0.080	0.000	0.048
0.2-0.4	0.026	0.849	0.063	0.061	0.001	0.775		**0.2-0.4**	0.024	0.865	0.059	0.050	0.002	0.716
0.4-0.6	0.030	0.425	0.364	0.181	0.001	0.071		**0.4-0.6**	0.015	0.473	0.356	0.155	0.001	0.092
0.6-0.8	0.050	0.440	0.089	0.420	0.001	0.118		**0.6-0.8**	0.019	0.475	0.059	0.445	0.001	0.142
>0.8	0.021	0.638	0.106	0.213	0.021	0.001		**>0.8**	0.019	0.692	0.056	0.112	0.122	0.002
	Age 45-49													
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**								
≤0.2	0.361	0.547	0.026	0.065	0.002	0.049								
0.2-0.4	0.015	0.896	0.047	0.041	0.002	0.751								
0.4-0.6	0.011	0.493	0.397	0.097	0.002	0.078								
0.6-0.8	0.007	0.528	0.047	0.411	0.006	0.118								
>0.8	0.002	0.311	0.006	0.347	0.334	0.005								

Notes: Base year METR given on left-hand side and rows sum to 100%. Conditional on working in both years under consideration. Authors' calculations based on simulated data.

Table 8. 5-year transition matrix for PTR bands at different ages

	Age 25-29								Age 35-39					
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**			**≤0.2**	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**
≤0.2	0.612	0.198	0.135	0.027	0.028	0.219		**≤0.2**	0.654	0.206	0.090	0.027	0.023	0.254
0.2-0.4	0.140	0.586	0.233	0.033	0.008	0.320		**0.2-0.4**	0.128	0.646	0.184	0.034	0.008	0.344
0.4-0.6	0.125	0.264	0.553	0.042	0.015	0.368		**0.4-0.6**	0.081	0.237	0.619	0.048	0.015	0.311
0.6-0.8	0.128	0.160	0.256	0.389	0.068	0.051		**0.6-0.8**	0.117	0.207	0.270	0.352	0.055	0.059
>0.8	0.227	0.104	0.151	0.101	0.418	0.041		**>0.8**	0.224	0.113	0.199	0.107	0.357	0.032
	Age 45-49													
	≤0.2	**0.2-0.4**	**0.4-0.6**	**0.6-0.8**	**>0.8**	**Share**								
≤0.2	0.650	0.208	0.099	0.023	0.020	0.235								
0.2-0.4	0.119	0.691	0.164	0.020	0.006	0.394								
0.4-0.6	0.057	0.280	0.621	0.036	0.006	0.293								
0.6-0.8	0.092	0.179	0.272	0.423	0.035	0.055								
>0.8	0.181	0.103	0.120	0.247	0.349	0.023								

Notes: Base year PTR given on left-hand side and rows sum to 100%. Authors' calculations based on simulated data.

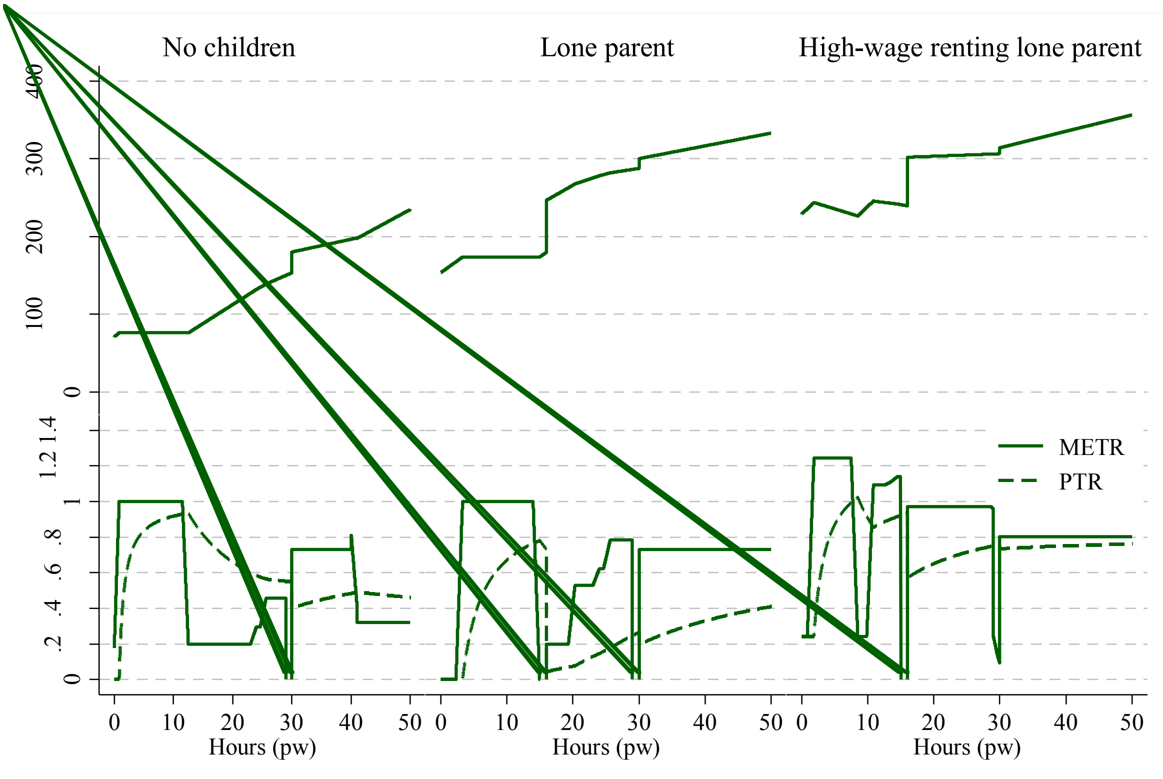
Table 9. Five-year transition matrices for family types at different ages

	Start of working life						Age 25			
	Si0Kd	Co0Kd	Si1Kd	Co1Kd			Si0Kd	Co0Kd	Si1Kd	Co1Kd
Si0Kd	0.54	0.26	0.09	0.11		Si0Kd	0.59	0.24	0.05	0.11
Co0Kd	0.15	0.50	0.07	0.29		Co0Kd	0.10	0.40	0.05	0.45
Si1Kd	0.00	0.00	0.64	0.36		Si1Kd	0.00	0.00	0.64	0.36
Co1Kd	0.00	0.00	0.31	0.69		Co1Kd	0.00	0.00	0.19	0.82
	Age 35						Age 45			
	Si0Kd	Co0Kd	Si1Kd	Co1Kd			Si0Kd	Co0Kd	Si1Kd	Co1Kd
Si0Kd	0.71	0.20	0.04	0.05		Si0Kd	0.92	0.08	0.00	0.00
Co0Kd	0.06	0.52	0.02	0.40		Co0Kd	0.07	0.93	0.00	0.00
Si1Kd	0.07	0.03	0.66	0.24		Si1Kd	0.33	0.02	0.60	0.05
Co1Kd	0.00	0.03	0.07	0.90		Co1Kd	0.02	0.26	0.04	0.67

Notes: Base year circumstances given on left-hand side and rows sum to 100%. Si0Kd = childless singles, Co0Kd = childless couples, Si1Kd = lone mothers and Cou1Kd = couple parents. Authors' calculations based on simulated data.

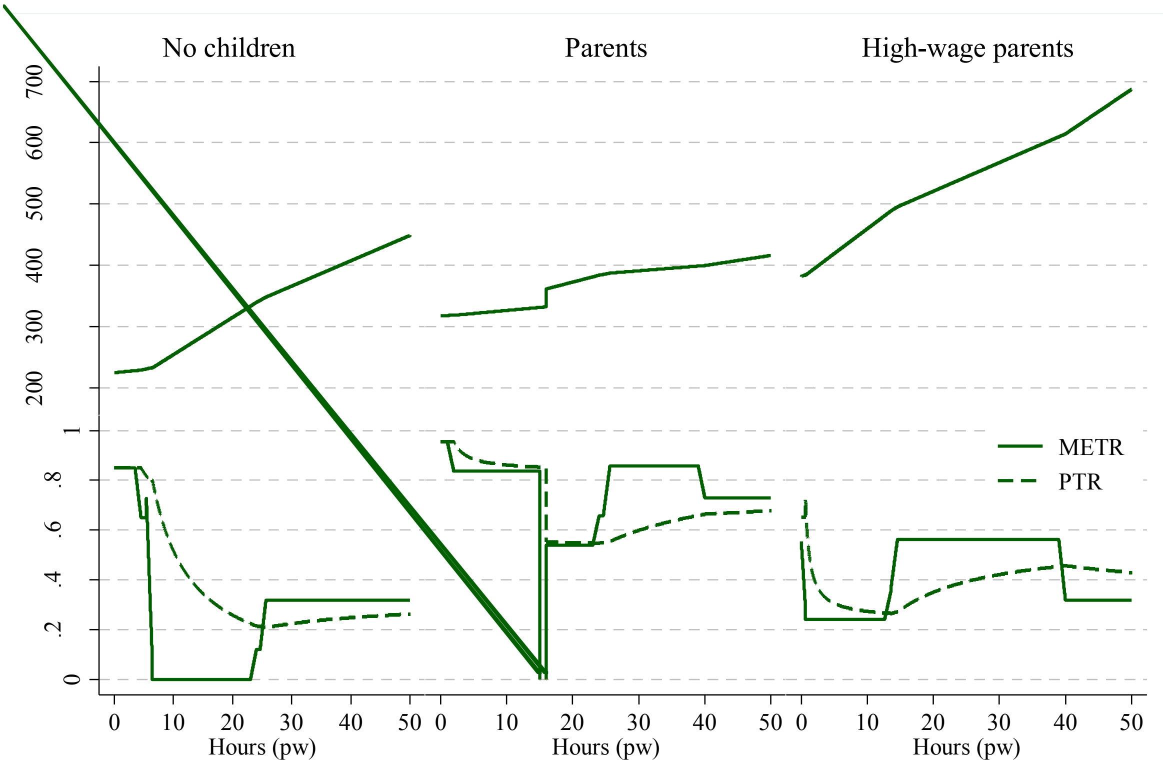
Figures

Figure 1. Example budget constraints and work incentive measures for single individuals



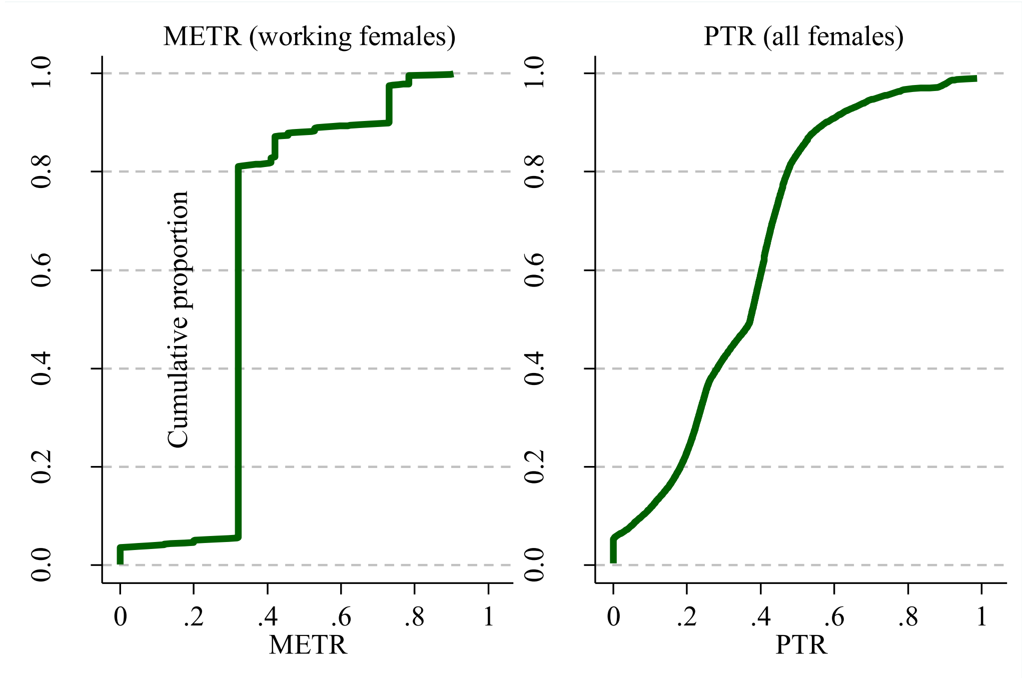
Notes: The “No children” panel assumes the April 2012 minimum wage (£6.08ph) and no rent. The “Lone mother” panel adds a child aged four and assumes nothing is spent on childcare. The “High-wage renting lone mother” panel assumes a wage at the 75th percentile of female wages (£10.70ph), rent of £75pw, and positive childcare costs (£2.60ph for every hour worked). Arrows at zero on the METR series indicate that the METR goes negative at this point. Authors’ calculations.

Figure 2. Example budget constraints and work incentive measures for couple individuals



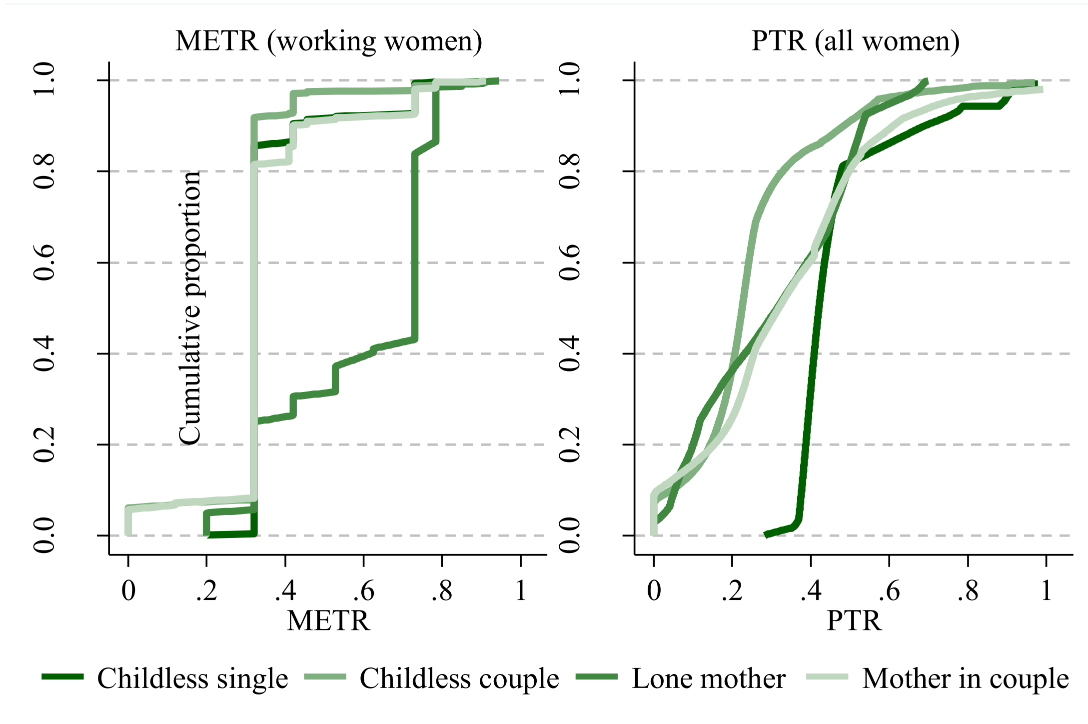
Notes: The "No children" panel assumes both individuals earn the April 2012 minimum wage (£6.08ph). The partner works 40 hours per week and the family pays rent of £75pw. The "Parents" panel adds a child aged four and positive childcare costs (£2.60ph for every hour worked), but assumes no rent. The "High-wage parents" panel both members of the couple earn a wage equal to the 75th percentile of the appropriate gender-specific age wage distribution (£10.70ph and £12.14ph for females and males respectively). The family faces childcare costs (£2.60ph for every hour worked) but no rent. Arrows at zero on the METR series indicate that the METR goes negative at this point. Authors' calculations.

Figure 3. Cross-sectional distributions of METRs and PTRs



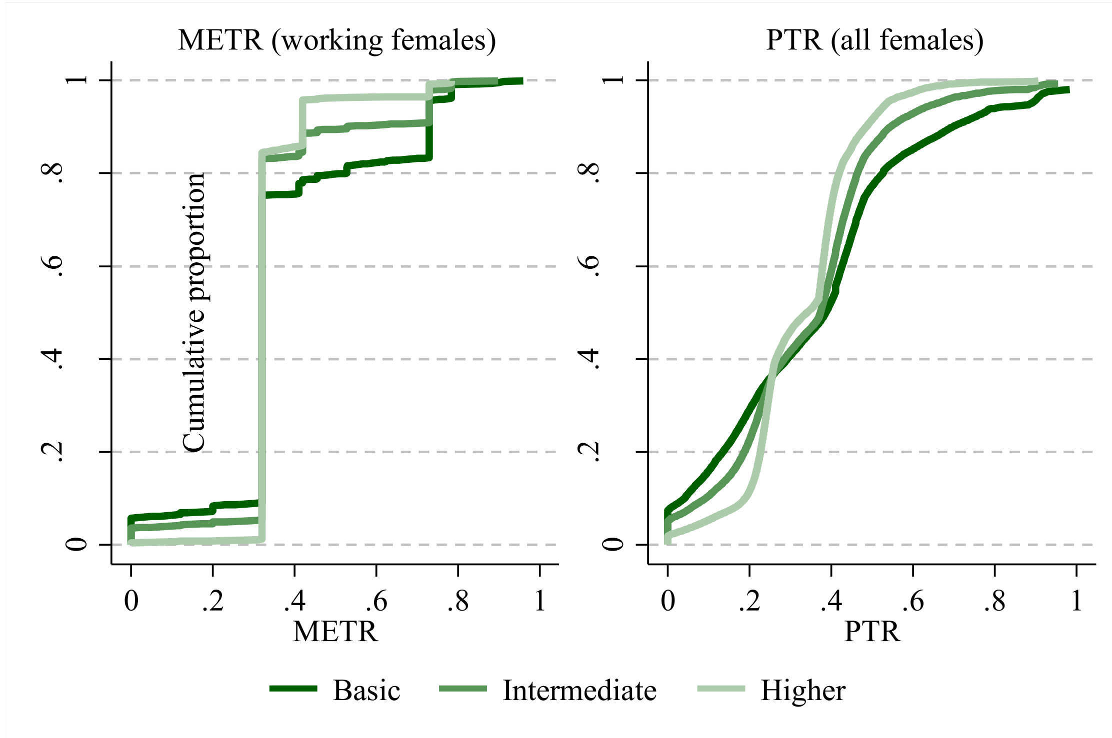
Notes: Authors' calculations based on simulated data.

Figure 4. Cross-sectional distributions of METR and PTRs, by family type



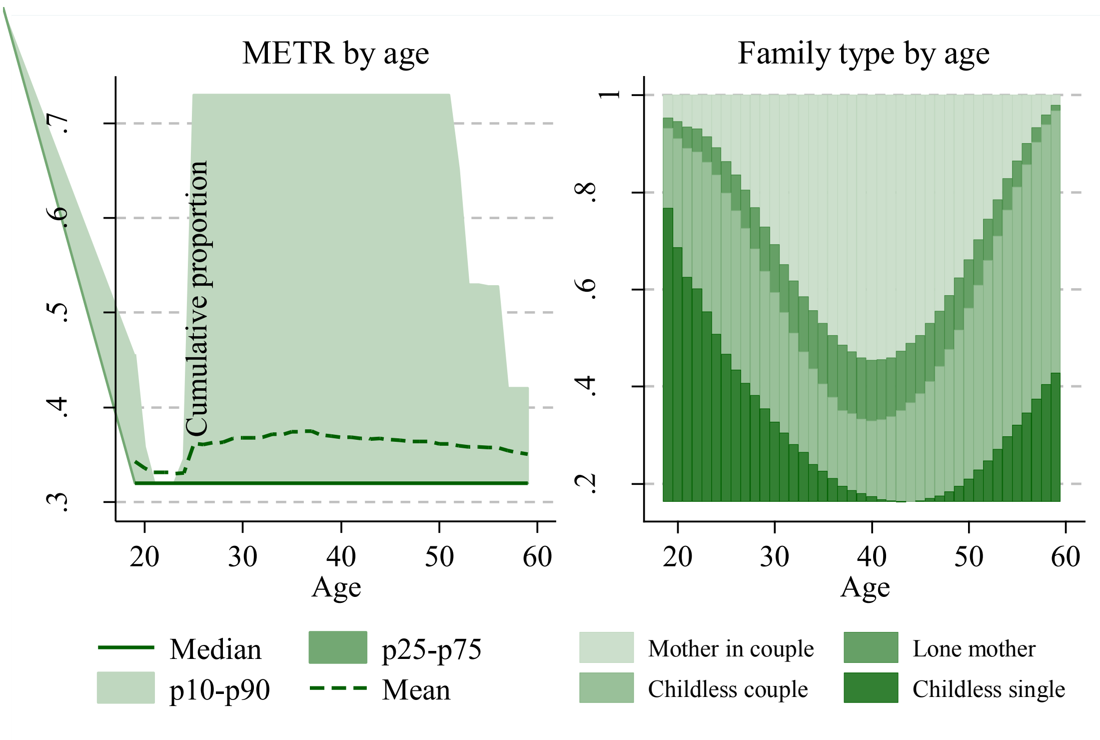
Notes: Authors' calculations based on simulated data.

Figure 5. Cross-sectional distributions of METRs and PTRs, by education



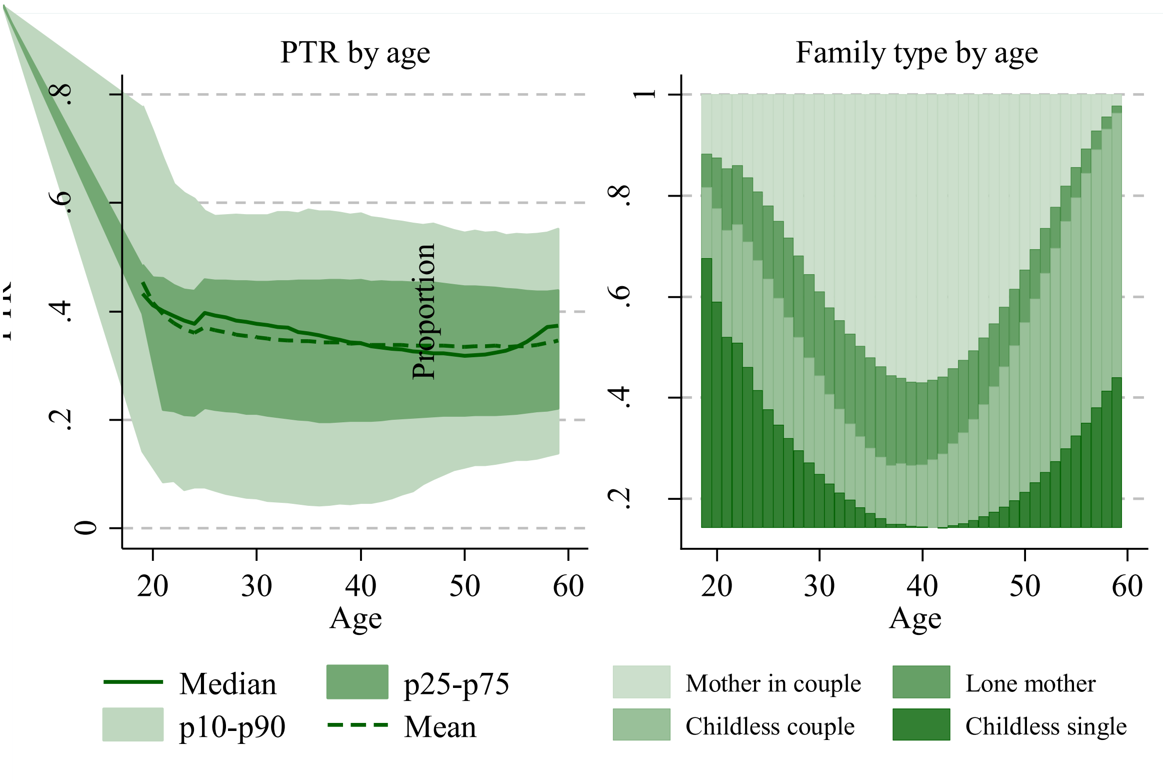
Notes: Authors' calculations based on simulated data.

Figure 6. Distribution of METRs and family type for working women across the lifecycle



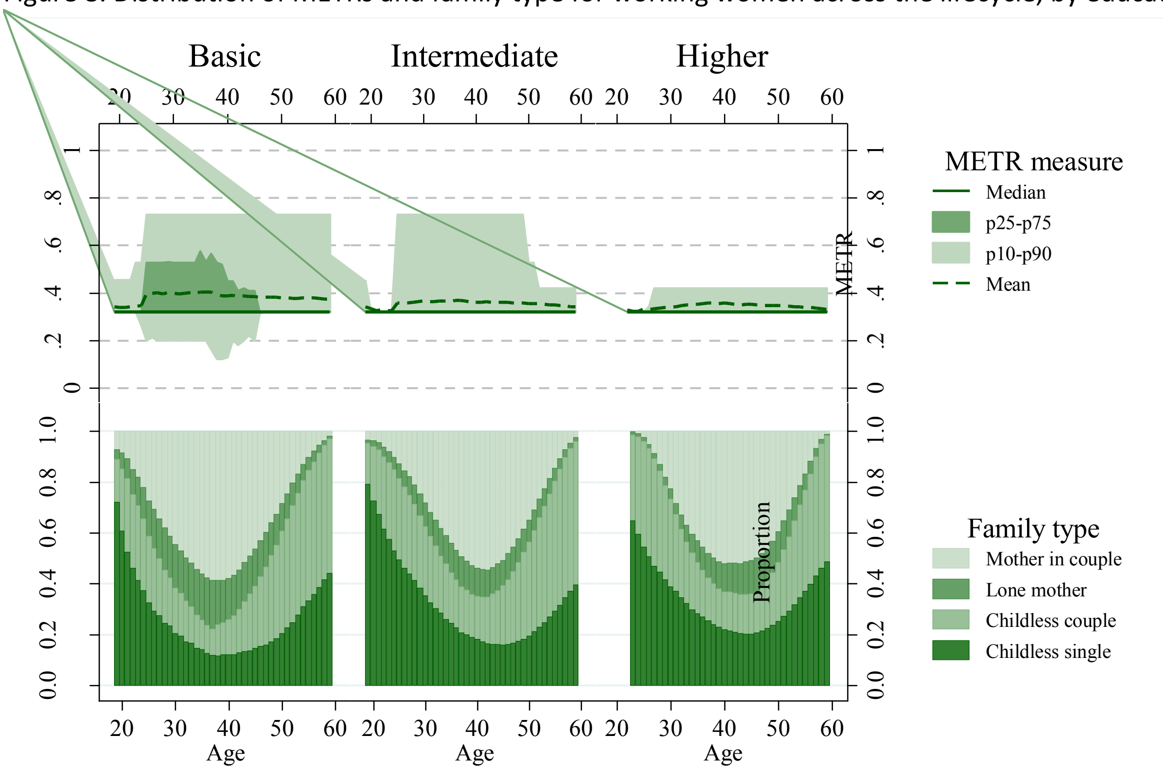
Notes: Authors' calculations based on simulated data.

Figure 7. Distribution of PTRs and family type for all women across the lifecycle



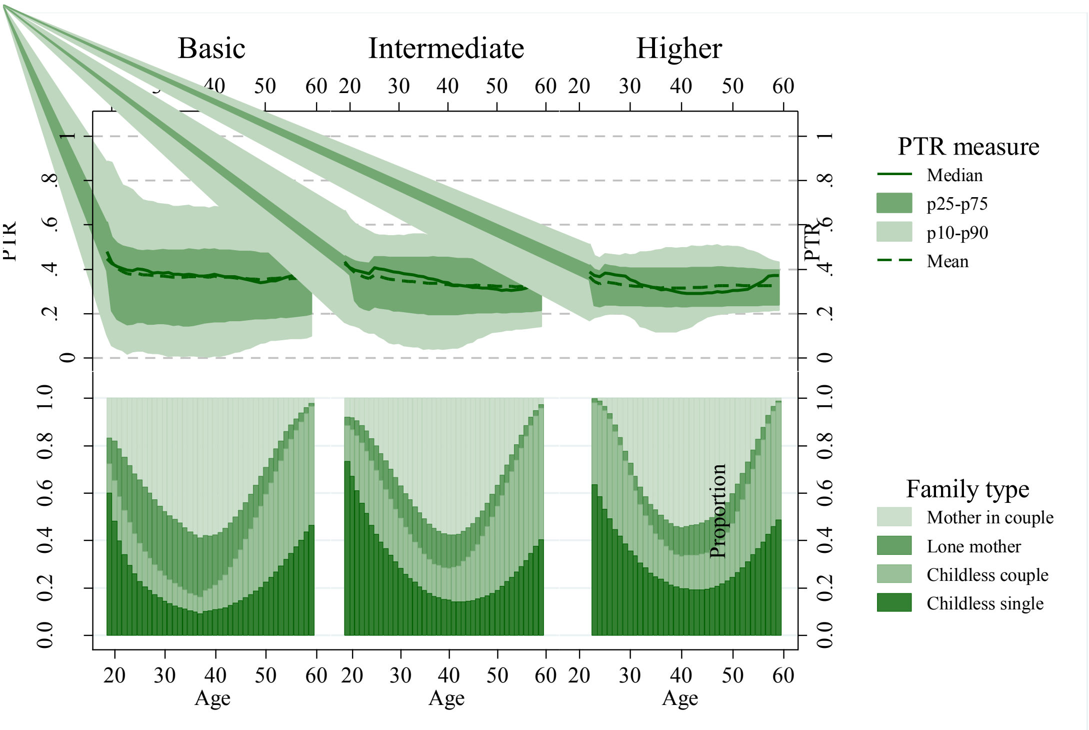
Notes: Authors' calculations based on simulated data.

Figure 8. Distribution of METRs and family type for working women across the lifecycle, by education



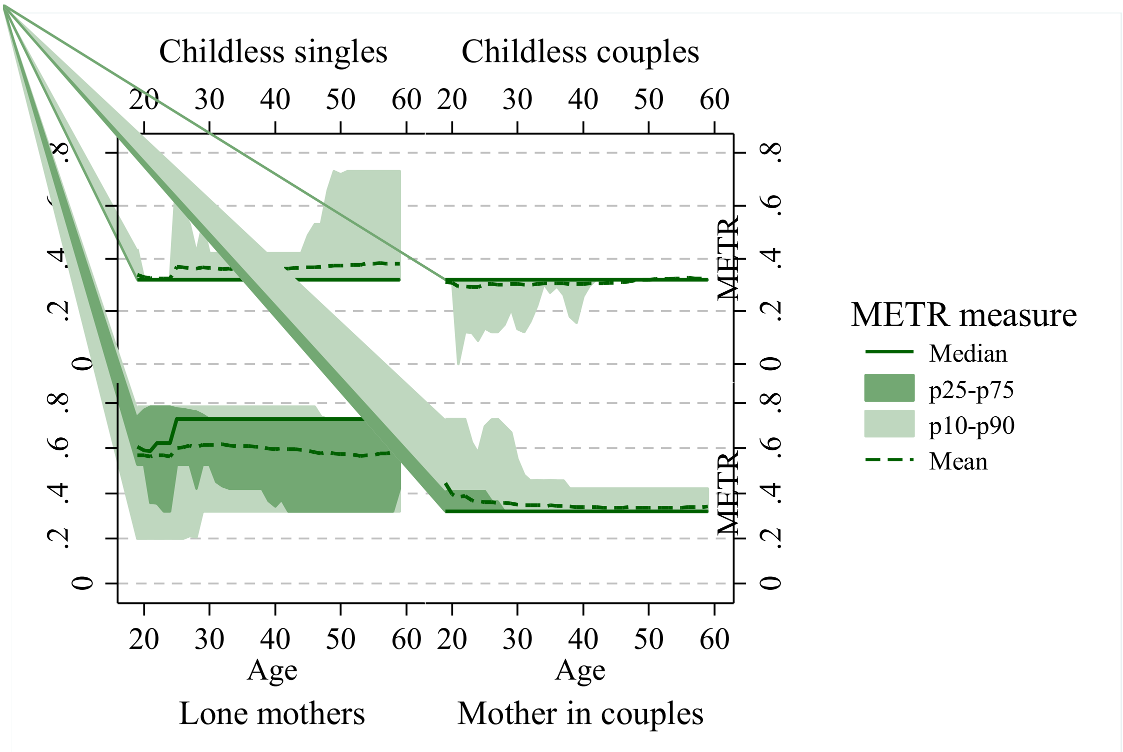
Notes: Authors' calculations based on simulated data.

Figure 9. Distribution of PTRs and family types for all women across the lifecycle: by education



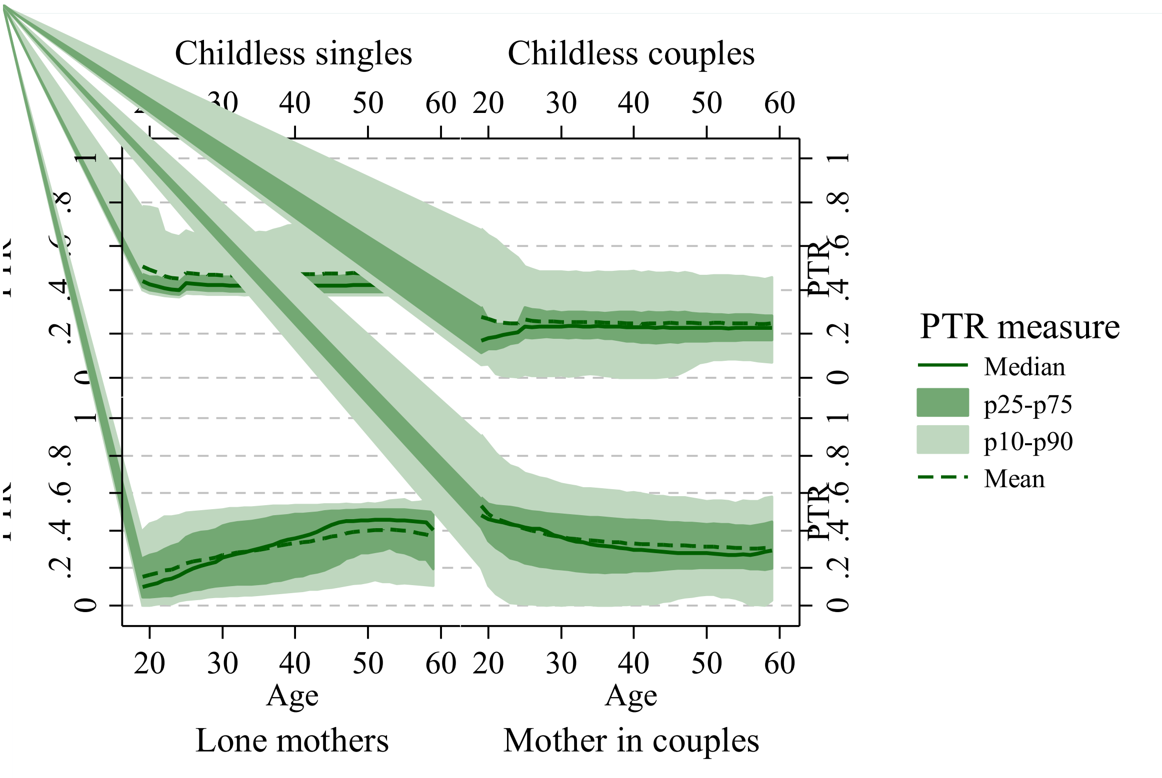
Notes: Authors' calculations based on simulated data.

Figure 10. Distribution of METRs for working women across the lifecycle, by family type



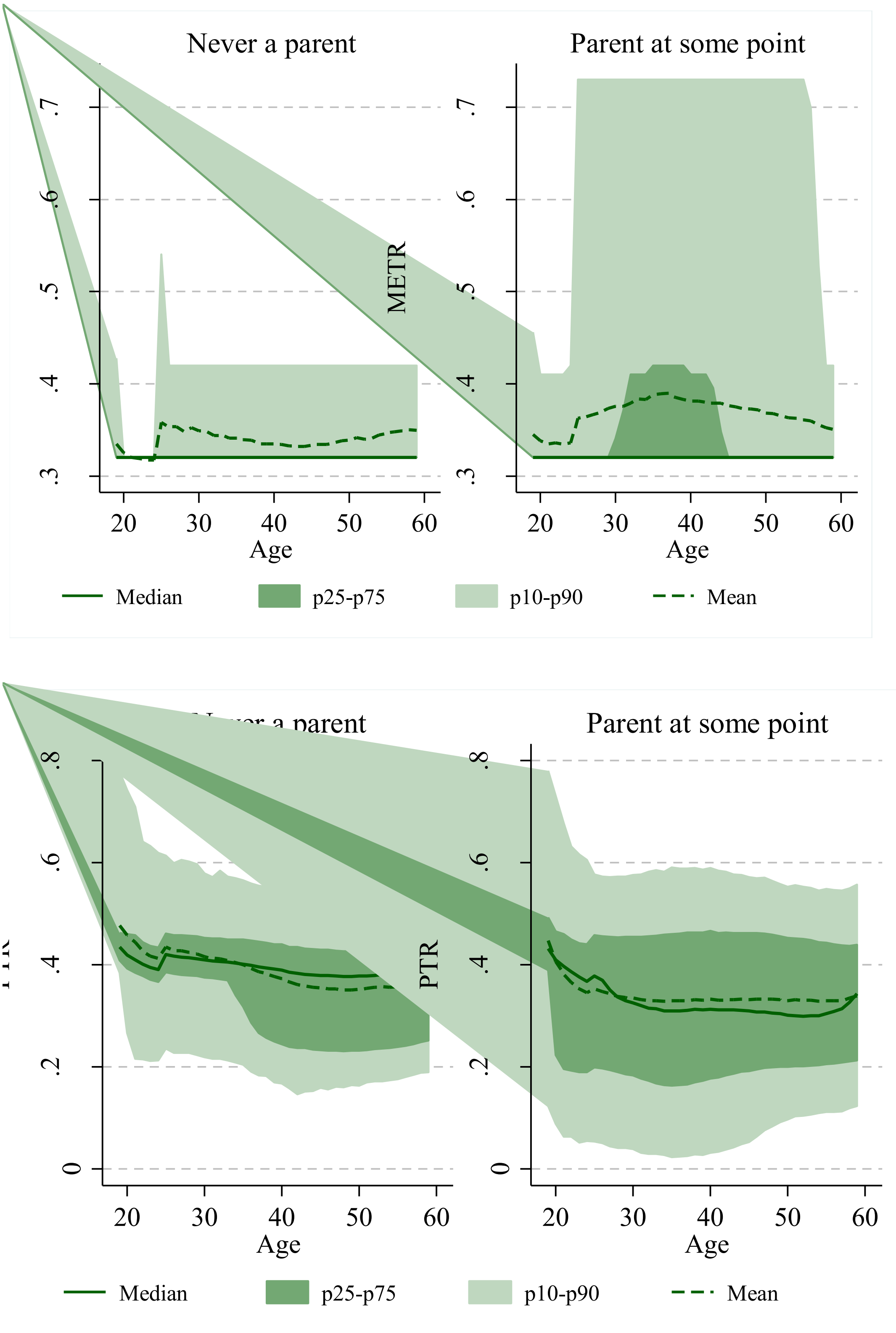
Notes: Size and composition of each group changes with age. Authors' calculations based on simulated data.

Figure 11. Distribution of PTRs for all women across the lifecycle, by family type



Notes: Size and composition of each group changes with age. Authors' calculations based on simulated data.

Figure 12. Distribution of METRs and PTRs for working women across the lifecycle, by whether ever a parent



Notes: Authors' calculations based on simulated data.