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# Home production, employment, and monetary policy

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ABSTRACT

I extend the textbook Dynamic New Keynesian (DNK) model to include home production and labor supply decisions along both extensive and intensive margins. Home production introduces an asymmetrical effect of wage changes on the employment rate and average labor hours. As a result, the cyclicality of total labor hours becomes ambiguous. When the elasticity of substitution between home and market goods is above a threshold value of 2, the aggregate hours become procyclical. In contrast, total labor hours are always countercyclical in the textbook model. This discrepancy is important for monetary policy: if a central bank excludes household production from its analysis, it mismeasures the output gap. The resulting welfare loss equals 0.013% in terms of consumption equivalence.



## 1. Introduction

In this paper, I ask how home production – activities such as meal preparation, laundry, and lawn care – affects the decisions over the two margins of labor supply in the presence of nominal rigidities.[1] I find that when the opportunity cost of home production increases, individuals work more days per period (extensive margin) while choosing slightly shorter workdays (intensive margin). As a result, total work hours increase in response to a market TFP shock, which is the opposite of what happens in the textbook DNK model. Moreover, adding the home sector or the two margin labor supply to the textbook model separately does not change the typical outcome of the textbook model. The main intuition is that home production has a stronger effect on employment rate than it does on average daily hours. An increase in wages results in a movement from home production to market work, which affects both participation and hours. Additionally, higher wages reduce the opportunity cost of each workday, which promotes further substitution from the home sector to the market sector – but only along the extensive margin. This behavior manifests in the "hump-shaped" response of total market hours to a TFP increase. This channel is present only in a model that *jointly* considers home production and the two margins of labor supply.

The discrepancies in the behavior of aggregate hours could lead to inconsistent monetary policy recommendations, depending on the choice of the theoretical model that is used to estimate the flexible level of market output. The one-sector model and the home production model imply different estimates of the flexible output level. In particular, the flexible level of output in the home production model is more responsive to shocks. If the one-sector estimate is used, the projected output gap is overestimated, which leads to an over-adjustment of the nominal rate. As a result, the welfare loss in consumption equivalence terms is 0.013%.

Workhorse macroeconomic models treat employment and hours as perfect substitutes. However, a vast empirical literature suggests that this assumption does not hold in the data. A recent study by Aguiar, Hurst, and Karabarbounis (2013) shows that almost 75% of the decline in total work hours during the Great Recession is due to a drop in employment, and only 25% of the decline is due to a decrease in the per-worker hours. This result implies that the distinction between the extensive and intensive margin of labor supply is important in the business cycle context. To relax the assumption of perfect substitutability between participation and hours of work, I introduce a fixed cost related to each day of work. An example of such a cost is time spent commuting to and from a job. Many authors have extensively discussed the existence and importance of these costs, including Kydland and Prescott (1989) and Hansen (1985).

Another time allocation decision that is relevant to the business cycle is the time spent on home production. Since market-produced goods and home-produced goods are substitutes, individuals can adjust their time between the two sectors depending on the relative marginal cost. Indeed, Aguiar et al. (2013) find that home production absorbs around 30% of foregone work hours at business cycle frequencies. I include the home sector in my model, using an empirically estimated benchmark value of 2.5 for the elasticity of

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[1] Home production does not include childcare because the income elasticity of time spent on child care is positive, while the income elasticity of time dedicated to home production is negative.

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**Table 1**
Daily time allocation of employed individuals, % of daily hours.

| | Market work | Home production | Leisure and sports | Personal care |
|---|---|---|---|---|
| Workday | 34.8 | 6.7 | 13.3 | 35.9 |
| Day off | 0 | 16.5 | 26.4 | 42.5 |

*Source*: own analysis of ATUS data.
The table displays averages across 88,109 employed individuals ages 18–65 during 2003–2014. Market work includes time spent on commuting and other work-related activities. Home production includes related travel and wait time. Personal care includes sleep.

substitution between home and market goods. I conduct sensitivity analysis for this parameter and find that for values above 1.2, employment is procyclical.

I use American Time Use Survey (ATUS) data to identify whether the allocation of time between home and market work is related to the extensive margin adjustment of labor supply. If the two decisions are independent, the daily time spent on home work should not differ significantly between workdays and days off. Table 1 shows that this is not the case for employed individuals. In fact, the share of time spent on home production during workdays is 6.7%, whereas on days off it reaches 16.5%. Additionally, once individuals choose whether to work on a given day or not, their average workday is 8.4 hours. On a day off, this time is split between home production, leisure, and personal care (including sleep), such that the time spent on each activity increases.

These facts indicate that labor supply decisions are more complex than the simple labor-leisure choice in standard macroeconomic models. Therefore, I develop a model that (1) separates the labor supply decision in both an extensive and intensive margin and (2) includes home production as an additional labor-leisure decision margin. My model nests the standard DNK model, the DNK model with two margins of labor supply without home production, and the DNK model with home production and one margin of labor supply.

I then study the labor supply response to a one standard deviation market TFP shock in my model. As the home sector becomes relatively less productive, agents substitute away from home-produced goods towards market-produced good. A market TFP shock, therefore, decreases the total time spent on home production and increases the total market hours. This first effect is the relative productivity effect which *symmetrically* affects both margins of labor supply. Additionally, a positive TFP shock makes the market participation less costly; and, when choosing to have more workdays, individuals could choose to work a little less each day, while still increasing their total hours of work. As a result, an *asymmetrical* response of extensive versus intensive margins of labor is introduced to the model. This asymmetry does not exist if there is no home production or only one margin of labor supply in the model.

I next discuss how a central bank should measure the output gap and the implications of this measure for welfare. I find that the welfare loss resulting from measuring the output gap incorrectly equals 0.013 percent% in terms of consumption equivalence. This number is significant, considering the fact that this loss arises purely from the measurement error and not from a choice of a rule. Solving for the optimal coefficients on inflation and the output gap shows that when the output gap is mismeasured, the optimal coefficient on the gap is zero. However, if the output gap is measured correctly, the optimal coefficient is 1. This result implies that the gain from knowing the true output gap is substantial.

Benhabib, Rogerson, and Wright (1991) and Greenwood and Hercowitz (1991) were the first to consider home production within a real business cycle model. Their contribution has been complemented by work such as Perli (1998) and Campbell and Ludvigson (2001). Despite the fact that the real business cycle literature shows that home production is important, the implications of home production for monetary policy have been relatively unexplored. Only recently did Ngouana (2012) and Lester (2014) consider the home sector within a New Keynesian model. My paper complements the literature by extending the DNK model with home production to include an additional margin of adjustment, that is, the extensive and intensive labor supply decision, which turns out to be critical for the cyclicality of labor supply. Whereas earlier models either have pro-cyclical or counter-cyclical labor hours, my model shows that the cyclicality of labor is ambiguous and depends on the elasticity of substitution between market and home production.

## 2. The model

Time is discrete and has an infinite horizon. Each period consists of a large number of days. A representative agent engages in two types of production – market and home – and adjusts its labor supply along two margins, extensive (number of workdays) and intensive (hours per day). Labor-hiring firms do not differentiate between extensive and intensive margins of labor supply. The firm side of the economy is identical to that in the canonical DNK model. Home production is not paid and for self-consumption only. I refer to a day spent in market production as a workday and all other days as days off.

### 2.1. Representative agent

The representative agent has preferences over consumption and leisure and allocates his/her time between market work, home production, and leisure. The agent's total consumption is a CES aggregate of the market good consumption ($g_t^M$) and the home good consumption ($g_t^H$):

$$c_t = \left[\tau\left(g_t^M\right)^{(\xi-1)/\xi} + (1-\tau)\left(g_t^H\right)^{(\xi-1)/\xi}\right]^{\xi/(\xi-1)} \quad (1)$$

where $\tau$ is the relative weight of the market good and $\xi$ is the elasticity of substitution between the two goods.

To highlight the importance of the time allocation between workdays and days off, I introduce differentiated leisure in the model. On a given day, the agent's utility is:

$$U\left(c_t, l_t^w, l_t^o\right) = \begin{cases} u(c_t) - v_1\left(1-l_t^w\right) - \chi(e_t) & \text{if workday} \\ u(c_t) - v_2\left(1-l_t^o\right) & \text{if day off} \end{cases} \quad (2)$$

where $l_t^w$ is the average hours of leisure on workdays, $l_t^o$ is the average hours of leisure on days off, $v_1(\cdot)$ and $v_2(\cdot)$ are increasing and twice continuously differentiable functions, $e_t$ is the fraction of workdays in a period, and $\chi(e_t)$ is a fixed cost associated with each workday. An example of such cost is one's time spent commuting to/from a job.[2] The function $\chi(e_t)$ is twice continuously differentiable and increasing in $e_t$.

Motivated by the fact that employed individuals spend 2.5 times fewer hours on home production during workdays, I make a simplifying assumption that home production can occur only on days off. The daily time endowment is normalized to 1. The time constraint can then be written as:

$$1 = \begin{cases} h_t^M + l_t^w & \text{if workday} \\ h_t^H + l_t^o & \text{if day off} \end{cases} \quad (3)$$

[2] The importance of such costs has been discussed by many authors, including Kydland and Prescott (1989), and Hansen (1985).