Who Gets Jobs Matters: Monetary Policy and the Labour Market

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Abstract
We show that the effectiveness of monetary policy in a heterogeneous agent New Keynesian model depends to a large extent on who obtains jobs. If the more productive workers obtain jobs first, then the expansionary effects of monetary policy are significantly lower than if the jobs are obtained with the least productive workers. The reason is that more productive workers tend to have the largest savings and the lowest marginal propensities to consume, which limits the expansionary demand effects. In a realistic case where the most productive workers obtain jobs first, the expansionary effects of both standard monetary policy and non-standard policy such as forward guidance are substantially weaker.

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1 Introduction

The distribution of income matters substantially for macroeconomic fluctuations in the standard heterogeneous agent New Keynesian models (hereafter HANK). So far in most HANK models, the main concern has been the distribution of dividends, labour income and taxation (Werning (2015), Broer, Hansen, Krusell, and berg (2018), and Hagedorn, Luo, Manovskii, and Mitman (2018)). However, not much attention has been paid to the issue how labour income is distributed among the households during the business cycle, despite labour income being the most important income source for the majority of households. In this paper we investigate how the distribution of job creation across worker types affects the distribution of wage income. We show that it matters whether it is mostly the rich or the poor who obtain jobs during the boom (or lose them in a recession).

Labour literature typically claims that it is the least productive workers who lose jobs first during the recession and it is the most productive workers who tend to get jobs first during the boom (for example, see Den Haan and Sedlacek (2014)). Elsby, Hobijn, and Sahin (2010) find that male, younger, less educated workers, and individuals from ethnic minorities, experience steeper rises in unemployment during all recessions. Hoynes, Miller, and Schaller (2012) come to a similar conclusion using individual-level Current Population Survey (CPS), Merged Outgoing Rotation Group (MORG) data.¹ Workers with this characteristics are more likely to be poor. In the HANK-type models, whether the agents are rich or poor matters for their marginal propensities to consume, and therefore for aggregate demand.

A standard assumption in HANK models is that workers differ in their labour productivities (see McKay, Nakamura, and Steinsson (2016), McKay and Reis (2016), and many others), but there has been little consideration on how these productivities translate into workers’ employment prospects and therefore

¹Berger (2012) develops a model where labour productivity rises in recessions because firms restructure during recessions by laying off their least productive workers.
their labour income dynamics. Apart from Auclert and Rognlie (2018), who use results from Guvenen, Schulhofer-Wohl, Song, and Yogo (2017) to ration labour when wages are sticky, little attention has been paid to the question of who gets/loses jobs in the boom/recession. Guvenen, Schulhofer-Wohl, Song, and Yogo (2017) looked how individual earnings vary across wealth, but their analysis is unconditional. This means that labour rationing such as in Auclert and Rognlie (2018), is only a reduced form approach to modelling of the labour market.

This paper attempts to merge the findings from the labour literature regarding who and when gets jobs with the mechanisms present in the HANK-type models, where income distribution and its cyclical properties matter for aggregate fluctuations. We show that the effectiveness of monetary policy is significantly reduced if the most productive workers (who tend to be rich) get jobs first, in line with the labour literature. On the other hand, if the least productive workers (who tend to be poor) were to get jobs first, the power of monetary policy would be much enhanced.

2 Model

The core of the model is the by now standard heterogeneous agents New Keynesian model of McKay and Reis (2016) and McKay, Nakamura, and Steinsson (2016). We reproduce only the equations that we modify to include the more micro-founded labour market. The household decision problem is

$$V_t(b_t, z_{h,t}) = \max_{c_{h,t}, b_{h,t+1}, z_{h,t}} \left\{ \frac{c_{h,t}^{1-\gamma}}{1-\gamma} - \eta_1 \frac{s_{h,t}^{1+\eta_2}}{1+\eta_2} + \beta \sum_{z_{h,t+1}} P(z_{h,t+1}|z_{h,t}) V_{t+1}(b_{t+1}, z_{h,t+1}) \right\}$$

subject to

(1)
\[ c_{h,t} + \frac{b_{h,t+1}}{1+r_t} = b_{h,t} + p_{z_{h,t}}^W w_{h,t}s_{h,t} - \tau_{z_{h,t}} + \Pi_{z_{h,t}}, \]  

(2)

and

\[ b_{h,t+1} \geq 0. \]  

(3)

where \( c_{h,t} \) is consumption of household \( h \), \( b_{h,t} \) are its bond holdings, \( r_t \) is the real interest rate, \( s_{h,t} \) is the number of searching workers and \( p_{z_{h,t}}^W w_{h,t} \) is the expected wage earnings from searching for work (probability of finding work \( p_{z_{h,t}}^W \) times the wage rate \( w_{h,t} \)). \( \tau_{z_{h,t}} \) are taxes (levied as lump-sum depending on the household’s productivity, and \( \Pi_{z_{h,t}} \) are profits from intermediate goods firms and labour firms. \( P(z_{h,t+1} | z_{h,t}) \) is the probability of transitioning between various productivity states. We assume it follows a Markov process.

We assume that all intermediate goods firms and labour firms are held by an investment fund managed by a risk-neutral manager, who collects profits and distributes them as dividends to households.

Markets are incomplete. Households are allowed to save by holding and trading bonds issued by the government, but not equities.

Using the standard search-and-matching model in a heterogeneous-agent model where workers can have several different levels of productivity and labour markets are segmented necessitates some simplifications. The reason is that one cannot simply assume several laws of motion for workers, as is standard in the labour literature, as this would rapidly increase the number of state variables and made the model untractable. We simplify the model structure to make it tractable by making the following assumptions. First, we assume incomplete markets and heterogeneity between households, but full insurance within each household. Each household consists of a continuum of workers that have the same level of productivity and can be employed or unemployed, but all workers bring their incomes home at the end of each period and the house-
hold as a whole decides on consumption and saving. Households are subject
to household-specific shocks and can become more or less productive. This as-
sumption allows us that, within a household type, we can use the average rates
of employment, unemployment, matching probabilities, and wages.\textsuperscript{2}

Second, we assume that there are no laws of motion for (un)employment of
each type of households. The household sends its workers to search for work in
the beginning of each period. They either find work, in which case they bring
home wages, or they remain unemployed. At the end of the period, all employed
workers lose jobs and have to search again in the next period. This assumption,
while unrealistic, allows us to avoid an additional state variable (employment)
for each productivity type of the household. Because we have three produc-
tivity types, this would add three additional endogenous state variables to the
already existing one endogenous (asset holdings) and one exogenous (labour
productivity process).

2.1 Labour market

Labour market segments There is a separate labour market for each produc-
tivity type of households (in total, there are three labour market segments). On
each labour market segment indexed by the productivity type $z_h$ we have a sep-
arate matching function and matching probabilities:

$$m_{z_h,t} = \phi_{z_h} s_{z_h,t}^\mu v_{z_h,t}^{1-\mu},$$

where $m_{z_h,t}$ is the number of matches in the market $z_h$, $\phi_{z_h}$ is the labour-market-
segment-specific matching efficiency, $s_{z_h,t}$ is the number of searching workers,
and $v_{z_h,t}$ is the number of vacancies. $\mu$ is the elasticity of the matching function
with respect to the number of searching workers.

\textsuperscript{2}This considerably simplifies the model, as we do not have to track the employment history
of the household in addition to its productivity history.
The matching probability for the worker, \( p_{z_h,t}^W \) is

\[
p_{z_h,t}^W = \frac{m_{z_h,t}}{s_{z_h,t}} = \phi_z \left( \frac{\nu_{z_h,t}}{s_{z_h,t}} \right)^{1-\mu}, \quad (5)
\]

and the matching probability for the firm, \( p_{z_h,t}^F \) is

\[
p_{z_h,t}^F = \frac{m_{z_h,t}}{v_{z_h,t}} = \phi_z \left( \frac{v_{z_h,t}}{s_{z_h,t}} \right)^{-\mu}. \quad (6)
\]

**Households**

Households send workers to search until the cost of searching in terms of the lost time is equal to the expected benefits of having a worker employed. This implies, for a household with a productivity level \( z_h \):

\[
\eta_1 \left( l_{h,t} + u_{h,t} \right)^{\eta_2} c_{h,t}^{-\gamma} = p_{z_h,t}^W w_{z_h,t} + (1 - p_{z_h,t}^W) b, \quad (7)
\]

where \( b \) are unemployment benefits, \( (l_{h,t} + u_{h,t}) \) is the total amount of workers that the household sends in the beginning of the period to the job market to search for jobs. A fraction \( p_{z_h,t}^W \) of workers finds a job, earns the wage \( w_{z_h,t} \), while the remaining workers return to the household with no pay, but with unemployment benefits. Equation 7 is therefore similar to the free-entry condition for firms (see below) in that the cost of searching for work has to be equal to the expected value of obtaining the job. It is also similar to the first-order condition for standard labour supply model (if \( p_{z_h,t}^W = 1 \), so that everyone finds a job, and \( b = 0 \), this reduces to the standard labour supply condition).

Again, recall that at the end of the period, employed workers bring home the earnings and the household as a whole decides on consumption, saving, etc. Therefore, we have full insurance within the household. Note that between the households, markets are incomplete (and there is no insurance).

**Labour firms**

We assume that each productivity segment of the labour market is a separate labour market with its own labour firms. Labour firms hire workers
and sell their effective labour as a homogeneous good at a competitive aggregate wage $\omega_t$ to the intermediate-goods firms. Each labour firm employs one worker. The value function of the labour firm is

$$J_{zh,t} = \omega_t z_{h,t} - w_{zh,t},$$

where $\omega_t z_{h,t}$ is the total revenue received by the labour firm from selling labour services (one worker provides labour services corresponding to his productivity $z_{h,t}$, which is sold to the intermediate-goods firm at the rate $\omega_t$). The labour firm pays the worker wage $w_{zh,t}$ and returns profits to the household as lump-sum.

The free-entry condition for labour firms is

$$\psi_{zh} = p_{zh}^F J_{zh,t},$$

where $\psi_{zh}$ is the vacancy posting cost in the labour market segment with productivity $z_h$. In equilibrium, the labour firm’s optimality condition states that the cost of posting a vacancy in the beginning of the period is equal to the probability that the firm will find a worker, times the value of that worker for the firm (which is equal to the profit the firm will earn in this period).

**Wage determination** We assume that the wage rate that is paid to the workers in each segment is a fraction $\alpha_{zh}$ of the aggregate wage rate.

$$w_{zh,t} = (1 - \alpha_{zh}) \omega_t.$$  

The aggregate wage rate is determined in equilibrium as the wage that equates the labour demand from intermediate goods firms with the labour services’ supply from labour firms (and therefore the labour supply from households).
3 Results

We first simulate an expansionary and persistent monetary policy shock (a persistent reduction in real interest rate). We assume wages are rigid to a different degree in each group of households (rich, medium-class, poor), as this allows us to vary the degree to which certain group of households gets jobs. Figure 1 shows the result.

The result that stands out most is the amplified increase in output, consumption and labour when it is mostly the poor agents who tend to receive jobs. The main reason for this finding is that those who are poor have the highest marginal propensities to consume, as they are the most likely to be those who are constrained. This means that if they obtain jobs, they also get more income and can consume more. In a New Keynesian setting, this increase in demand drives the response in output, which in turn increases the demand for labour, and if this labour comes mostly from the poor, further amplifies demand.

In contrast, if it is mainly the rich who obtain jobs, then the additional labour income is received by the agents with the lowest marginal propensity to consume. This means that the amplification effect from an increase in consumption back to the labour market is not quantitatively important because consumption does not increase by much.

The intermediate case where all receive jobs in proportion is in between the two cases, but much closer to the case where the rich receive jobs. The main reason for this is that the majority of the mass of households (75% of the invariant distribution) is either rich or middle-class, with relatively small marginal propensities to consume. If for the same monetary policy shock jobs are distributed evenly across productivity types, only about 25% of jobs go to the poor. Moreover, the demand increase from the rich and the middle class workers obtaining the jobs is relatively small compared to the case where the poor receive jobs, and the total number of new jobs is smaller. As a result, there
Figure 1: Effectiveness of monetary policy depending on who gets jobs, rigid wages

Notes: All variables are reported in percent deviations from the steady state. Units on the horizontal axis are quarters.

is less amplification.

We repeat the experiment for the case where there is a news shock regarding monetary policy (this is often referred to as a forward guidance). Specifically, the central bank announces that it will decrease the real interest rate 10 quarters
Figure 2: Effectiveness of forward guidance depending on who gets jobs

Notes: All variables are reported in percent deviations from the steady state. Units on the horizontal axis are quarters.

in the future. Figure 2 shows how the effectiveness of such policy depends on the agents that receive jobs.

The main question that relates to both the strength of the standard monetary policy and to the effectiveness of non-standard policies such as forward guidance, is who obtains jobs when the economy is recovering. We argue that
the agents most likely to receive jobs are also the agents who are the most productive and hence tend to be the wealthiest. This implies that monetary policy can be less effective than typically thought.

The labour literature typically argues that matches that are created first are those with the highest match surplus, i.e., those for the most productive workers (Den Haan and Sedlacek (2014)). This implies, given our results, that most realistic scenario is the one where the most productive workers, which also tend to be the richest, are the first to obtain jobs. Because they have the lowest MPC the general equilibrium effects are going to be attenuated.

4 Conclusions

In this paper we show, that the effectiveness of monetary policy in a heterogeneous agent New Keynesian model depends to a large extent on who obtains jobs. If the more productive workers obtain jobs first, then the expansionary effects of monetary policy are significantly lower than if the jobs are obtained with the least productive workers. The reason is that more productive workers tend to have the largest savings and the lowest marginal propensities to consume, which limits the expansionary demand effects. The labour literature typically argues that matches that are created first are those with the highest match surplus, which means that these are the matches for the most productive workers. In a realistic case where the most productive workers obtain jobs first, the expansionary effects of both standard monetary policy and non-standard policy such as forward guidance are substantially weaker.
References


### A Main model equations

This section closely follows McKay, Nakamura, and Steinsson (2016).

**Final goods and intermediate goods.** Final goods $Y_t$ are produced by bundling intermediate goods $y_{j,t}$ using

$$Y_t = \left( \int_0^1 y_{j,t}^{\frac{1}{\mu}} d j \right)^\mu$$  \hspace{1cm} (11)

Intermediate goods are produced using

$$y_{j,t} = n_{j,t}.$$  \hspace{1cm} (12)

The final good is produced by a representative competitive firm, but intermediate goods are produced by monopolistically competitive firms. These firms are subject to pricing frictions and can update their prices only with a probability $\theta$ per period. The optimisation of the final goods producer implies

$$y_{j,t} = \left( \frac{p_{j,t}}{P_t} \right)^{\frac{1}{\mu}} Y_t,$$  \hspace{1cm} (13)

where $p_{j,t}$ is the price charged by firm $j$ at time $t$ and $P_t$ is the aggregate price level, given by

$$P_t = \left( \int_0^1 p_{j,t}^{\frac{1}{\mu}} d j \right)^{1-\mu}.$$  \hspace{1cm} (14)

The intermediate producer solves the following problem:

$$\max_{p^*_t, (y_{j,s}, n_{j,s})_{s=t}^\infty} \sum_{s=t}^\infty \beta^{s-t} (1-\theta)^{s-t} \left( \frac{p^*_s}{P_s} y_{j,s} - W_s n_{j,s} \right),$$  \hspace{1cm} (15)

subject to 12 and 13. The solution to this problem is
\[ \frac{P_t^\ast}{P_t} = \frac{\sum_{s=t}^{\infty} \beta^{s-t}(1-\theta)^{s-t}\left(\frac{p^t_s}{P^t_s}\right)^{\mu \pi} Y_s \mu W_s}{\sum_{s=t}^{\infty} \beta^{s-t}(1-\theta)^{s-t}\left(\frac{p^t_s}{P^t_s}\right)^{\mu \pi} Y_s}. \] (16)

**Government.** The government runs a balanced budget, using taxes levied based on (exogenous) labour productivity only to pay interest on otherwise constant bond stock,

\[ \frac{B}{1+r_t} + \sum_z \Gamma^z(z) \tau_t(z) = B \] (17)

The relation between nominal rate, real rate, and inflation is

\[ 1 + r_t = \frac{1 + i_t}{1 + \pi_{t+1}}. \] (18)

**Equilibrium.** In equilibrium, if \( \Gamma_t(b,z) \) is the distribution of households asset holdings \( b \) over the idiosyncratic state \( z \) at time \( t \), that satisfies

\[ \Gamma_{t+1}(B,z') = \int \{ (b,z) : g_t(b,z) \in B \} \Pr(z'|z) d\Gamma_t(b,z), \] (19)

where \( g_t(b,z) \) is the decision rule for household’s savings.

Aggregate production is

\[ N_t = \int n_j d_j = S_t Y_t, \] (20)

where \( S_t \) is price dispersion because of nominal rigidities, defined as

\[ S_t = \int_0^1 \left( \frac{p^t_j}{P^t} \right) d_j \] (21)

with the law of motion

\[ S_{t+1} = (1 - \theta)S_t(1 + \pi_{t+1})^{\mu \pi} + \theta \left( \frac{p^t_{t+1}}{P^t_{t+1}} \right)^{\mu \pi}. \] (22)
Inflation can be defined as

\[ 1 + \pi_t = \left( \frac{1 - \theta}{1 - \theta \left( \frac{\pi_t^*}{\pi_t} \right)^{1-\mu}} \right)^{1-\mu}. \]  \hspace{1cm} (23)

In addition, labour markets clear, bond markets clear, and goods markets clear (taking into account that dividends are \( D_t = Y_t - W_t N_t \))

\[ B = \int g_t(b,z) d\Gamma_t(b,z), \]  \hspace{1cm} (24)

\[ Y_t = C_t. \]  \hspace{1cm} (25)

In equilibrium, all decision rules, value functions satisfy all optimality conditions, definitions, and budget constraints.