

NBP Working Paper No. 296

Employment prospects and the propagation of fiscal stimulus

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The opinions expressed in this publication are those of the authors and do not necessarily reflect the position of Narodowy Bank Polski.

Acknowledgments

I would like to thank P. Beaudry, D. Caldara, Ł. Drozd, A. Ferriere, P. Michailat, C. Moser, K. Pytka, P. Rendahl, S. Schmitt-Grohé, L. Tesar, C. Teulings and L. Uren and participants of RES 2017, Search and Matching Annual Meeting in Barcelona and NBP Summer Workshops for helpful discussions and comments at various stages of this project.

Published by:
Narodowy Bank Polski
Education & Publishing Department
ul. Świętokrzyska 11/21
00-919 Warszawa, Poland
www.nbp.pl

ISSN 2084-624X

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Abstract

I study a novel channel that amplifies the effects of a rise in government purchases. To explore the mechanism, I use a model with uninsured idiosyncratic risk, frictional labor market and sticky prices. Fiscal stimulus increases aggregate demand and boosts job creation. The latter improves employment prospects by reducing unemployment risk faced by households. This, in turn, weakens precautionary motives and raises private consumption which strengthens the initial fiscal impulse. Quantitative analysis indicates that magnitude of the employment prospects channel is substantial: without this mechanism, crowding out of aggregate consumption associated with higher government expenditures is three times larger. Interestingly, in contrast to many recent works using heterogeneous agent models, the analyzed channel does not rely on behavior of liquidity constrained, hand-to-mouth agents.

JEL Classification: D30, E62, H23, H30, H31

Keywords: Heterogeneous Agents, Frictional Markets, Fiscal Stimulus

1 Introduction

The Great Recession of 2008 accompanied by nominal interest rates close to zero gave rise to a heated debate about the usefulness of fiscal policy for spurring a recovery. As a consequence, a growing body of research started to analyze the channels through which fiscal shocks are propagated to economy. This paper studies a powerful transmission mechanism of a rise in government expenditures that works through labor market.

In particular, the channel analyzed in my paper is based on a combination of two empirically established premises. First, households are not able to insure against unemployment and thus cut private expenditures due to stronger precautionary motives in response to rising pessimism about future job prospects and suffer from substantial drops in income and consumption expenditures as they lose jobs. For instance, Carroll (1992) presents evidence on the role of unemployment expectations in determining current consumption and finds that poor job prospects explain a substantial part of the weakness in consumption during recessions. Moreover, Kolsrud et al. (2015) analyze Swedish data and find that average drop in consumption expenditures during the first year of an unemployment spell equals 32%. Second, there is an ample evidence suggesting that fiscal packages have a large impact on job creation and employment. For example, Chodorow-Reich et al. (2012) and Serrato and Wingender (2016) find that \$100,000 of additional government expenditures in the US generate 3.8 and 3.3 job-years, respectively. Moreover, using a structural VAR, Monacelli et al. (2010) show that an increase in fiscal purchases equal to 1% of GDP lowers unemployment by 0.6% and raises labor market tightness by 20%.

Motivated by these observations, I study a novel channel which amplifies the macroeconomic effects of higher government purchases through improvement in employment prospects. Fiscal expansion fuels aggregate demand and, due to price rigidities, leads to adjustment in the quantity of produced goods. The latter requires larger output capacity across firms and hence increases incentives to recruit additional workers. Higher demand for labor improves employment prospects faced by households as job creation translates into higher job finding and lower job separation rates and, as a result, shorter expected unemployment spells in the future. Lower unemployment risk, in turn, weakens precautionary motives, raises consumer confidence and stimulates private consumption which amplifies the effects of fiscal

stimulus. On top of that, since changes in employment are prolonged by labor market frictions, higher employment persists over time and stimulates output, consumption and job creation in future periods which, in turn, improves job prospects and stimulates private expenditures in the current period.

To quantify the employment prospects channel it is necessary to extend the standard Bewley-Huggett-Aiyagari model (BHA henceforth) along two dimensions. First ingredient that is required to analyze the problem are price rigidities, which guarantee that higher aggregate demand generated by fiscal package is not entirely absorbed by price adjustment.¹ Second, to account for the idiosyncratic, endogenous unemployment risk faced by households, I blend the BHA framework with the standard Diamond-Mortensen-Pissarides model of frictional labor market.

My paper is related to works studying the effects of fiscal policy shocks in models with heterogeneous households, in which a significant proportion of agents deviates from the consumption-savings behavior predicted by the permanent income hypothesis and thus exhibits relatively high levels of marginal propensity to consume (MPC). There are two groups of papers within that field: first of them focuses on the role of taxes and transfers (like McKay and Reis (2016), Den Haan et al. (2015)), and the second concentrates on the role of fiscal purchases (Brinca et al. (2017), Navarro and Ferriere (2016) and Hagedorn et al. (2017)).

McKay and Reis (2016) use a model with heterogeneous households and nominal rigidities to analyze the role of fiscal stabilizers and find that taxes and transfers that affect inequality and social insurance can have a large impact on the volatility of macroeconomic aggregates. Similarly to my paper, Den Haan et al. (2015) study the role of unemployment fears on precautionary motives and aggregate demand. In their work, a combination of uninsured unemployment risk, flexible prices of goods and nominal wage rigidities gives rise to deflationary spirals during recessions that

¹Moreover, as it has been noticed by Hagedorn et al. (2017), a combination of price stickiness and consumer heterogeneity in the BHA model (more precisely, the presence of households with high marginal propensity to consume) gives rise to income channel through which fiscal expansions affect private consumption: an increase in government purchases stimulates aggregate demand which, if sticky prices are in place, translates into higher output which, in turn, is associated with increase in labor demand. This raises employment, imposes an upward pressure upon wages and thus leads to rise in labor income. Since high MPC households spend a significant proportion of the increase in labor income on consumption then aggregate demand grows even further triggering higher labor demand, growth in labor income etc. It is thus clear, that price rigidity is key for existence of the feedback loop which describes the traditional logic underlying the fiscal multiplier.

squeeze firms' profits, induce layoffs that amplify the adverse effects of negative productivity shocks. They study the role of unemployment benefits in mitigating the dire consequences of deflationary spirals. From the technical point of view, in contrast to Den Haan et al. (2015), I assume sticky prices which puts my work closer to the standard New-Keynesian framework and I focus on the role of government expenditures instead of unemployment benefits. To illustrate the interplay between uninsured unemployment risk and aggregate demand, Den Haan et al. (2015) compare the transition path of main aggregates during recession in the baseline model with the one generated by the model with full risk sharing. In my paper, instead, I construct a decomposition method that allows to isolate the sole impact of the deterioration in employment prospects on aggregate consumption which has a clear, model-based interpretation.

Let us turn to works that use models with heterogeneous agents to study the role of fiscal purchases. Brinca et al. (2017) construct a life-cycle, overlapping generations model to study the relationship between inequality, measured with the level of income risk faced by agents, and the effects of fiscal consolidations. They find a strong positive relationship between inequality and recessive impact of fiscal consolidation programs and propose a theoretical mechanism that is based on the reaction of labor supply of non-constrained agents to fiscal shocks. In contrast to Brinca et al. (2017), I concentrate on the extensive margin of labor supply by studying a model with frictional labor market which enables to capture the effects of fiscal shocks on labor market flows and on idiosyncratic labor market risk, in which employed agents supply an identical number of hours worked.

Navarro and Ferriere (2016) study the impact of changes in government expenditures in the standard BHA model with labor indivisibility and flexible prices. They find that only an increase in government spending that is accompanied by a rise in tax progressivity is able to generate a positive response in aggregate consumption. The reason for this fact is intuitive: when tax progressivity increases, authorities are able to decrease the average tax level because they tax top incomes at higher rates. Main beneficiaries of the associated tax cuts are agents with low labor income who exhibit relatively high MPC. In contrast to Navarro and Ferriere (2016), I consider a BHA model with frictional labor and sticky prices in which government finances expenditures with a flat-rate tax that features a time-invariant lack of progressivity.²

²In addition to baseline simulation, which assumes that higher government purchases are fi-

The latter enables to separate the effects of a rise in government purchases from the transfer-like impact of changes in progressivity that accompanies fiscal expansion in Navarro and Ferriere (2016).

It seems that the closest work to mine is Hagedorn et al. (2017) who study the size of fiscal multiplier using a version of the BHA model with price adjustment costs as in Rotemberg (1982) and decompose the reaction of private consumption to government purchases into several channels to get a better understanding of mechanisms that propagate fiscal stimulus. There are, however, two substantial differences between my work and the paper of Hagedorn et al. (2017). First, I consider a different specification of labor market which features search frictions in my case. This implies that shifts in public expenditures affect labor market flows and unemployment risk which is a prerequisite for studying the role of changes in employment prospects during fiscal expansions. Second, in contrast to Hagedorn et al. (2017), my decomposition method of aggregate consumption, which is crucial for the isolation of employment prospects channel, is based on the total differentiation of aggregate consumption with respect to economic variables entering the household maximization problem.³

Interestingly, the employment prospect channel does not work through consumption behavior of liquidity constrained agents. This is because consumption of such agents is determined by their income and hence they are unable to react to a rise in expected future job-finding rates during fiscal expansion by raising their expenditures. This implies that the mechanism analyzed here is very different from the pass-through of monetary-fiscal policies analyzed in a large number of works that used heterogeneous agent models and underscored the role of hand-to-mouth consumers (see, for instance, Oh and Reis (2012), Kaplan et al. (2016)). A rationale for the quantitative significance of forces that abstract from the role of liquidity constrained agents in the policy transmission in heterogeneous agent frameworks is presented by Krueger et al. (2016), who analyze the cross-sectional patterns in households' consumption during the Great Recession and find that the decline in consumption at the bottom of the wealth distribution in years 2007-2009 in the US

nanced with taxes, I analyze the situation in which increased fiscal expenditures are financed with debt.

³The decomposition method used in this work can be seen as a discrete-time counterpart of the procedure applied by Kaplan et al. (2016).

cannot be simply explained by standard hand-to-mouth behavior, but primarily by changes in consumption behavior that occur through a drop in expenditure rates. Moreover, Krueger et al. (2016) use a calibrated model to establish that a decline in consumer confidence captured by the rise in precautionary motives can be an important driver of fluctuations in aggregate demand and output. By incorporating the Diamond-Mortensen-Pissarides frictions, I provide microfoundations for mechanisms described by Krueger et al. (2016) that become a powerful driver of fiscal policy potency.

The remaining sections of the paper are organized as follows. Section 2 presents the BHA model with frictional product market and sticky prices. In Section 3 I study the effects of an increase in government expenditures when monetary policy is relatively responsive to changes in macroeconomic environment and stimulus is financed with taxes. Section 4 describes the employment prospects channel. In Section 5 I consider two alternative scenarios of expansion. First of them assumes that the increase in government purchases is financed with debt. Second scenario analyzes expansion during which monetary policy is not responsive to changes in macroeconomic environment. Section 6 concludes.

2 Model

In this section, I describe the main building blocks of the model which is populated by heterogeneous households, identical retailers, representative firm and government. Time is infinite and divided into discrete periods. There is one type of good (consumption good) generated by firms that use production technology with labor as the only input. There are two assets actively traded in the economy: government bond b which earns nominal interest rate i and shares e that entitle to dividends d generated by firms. Price of shares in terms of consumption goods is denoted by J . To ease the notation, I assume in this section that economy is in stationary equilibrium.

2.1 Households

The model is populated by a continuum of households of measure one who face uninsurable idiosyncratic income and labor status shocks that are driven by exogenous changes in labor productivity z and endogenous shifts in job-finding rate f , respectively. Labor supply is exogenous and normalized to unity. Agents value consumption streams c only and the associated instantaneous utility function is denoted by $u(c)$ which is strictly increasing, strictly concave and satisfies the Inada conditions. By Π I denote the ratio between current price of consumption goods p and the price of those goods in the previous period p_{-1} :

$$\Pi = \frac{p}{p_{-1}}.$$

Household with productivity level z earns real wage $w \cdot z$ if it is employed, where w is the average real wage in the economy while the unemployed featuring productivity z receives unemployment benefit equal to $\nu \cdot w \cdot z$ where $\nu \in (0, 1)$ is the replacement rate. Idiosyncratic productivity shocks z follow a Markovian process that takes values in space Z . Employed households pay linear tax τ on labor income.⁴ Budget constraint faced by employed household reads:

$$c + b' + J \cdot e' = \frac{1+i}{\Pi} \cdot b + (J + d) \cdot e + (1 - \tau) \cdot w \cdot z$$

⁴Notice, that since the number of hours worked is fixed for employed household (i.e., equal to one) then labor income tax is not distortionary, i.e., it has no effect on labor supply.

where by primes I denote values of variables in the next period. For the unemployed, the constraint is:

$$c + b' + J \cdot e' = \frac{1+i}{\Pi} \cdot b + (J + d) \cdot e + \nu \cdot w \cdot z.$$

Similarly to Krusell et al. (2010), the equity price has to satisfy the following equation:

$$J = \frac{J' + d'}{\frac{1+i'}{\Pi'}} \quad (1)$$

which is implied by the absence of arbitrage and the fact that both assets are riskless. To avoid the curse of dimensionality when solving the model, I define state variable s that summarizes net worth held by household:

$$s \equiv b + \frac{(J + d) \cdot e}{\frac{1+i}{\Pi}}.$$

This coupled with the no-arbitrage condition 1 enables to reformulate the budget constraint of employed worker as:

$$c + s' = \frac{1+i}{\Pi} \cdot s + (1 - \tau) \cdot w \cdot z.$$

Analogous reformulation applies to the unemployed. Jobless household becomes employed with probability f' at the beginning of next period. Employed consumers lose jobs with probability $\sigma \cdot (1 - f')$ where $\sigma \in (0, 1)$ is exogenous separation rate. I adopt the convention that separations occur before hiring. In equilibrium job-finding rate f is endogenous and depends on labor market tightness x given by the ratio between job vacancies opened by firms and the proportion of households that remains without job at the beginning of period. The choice of next period balances s' is subject to borrowing constraint:

$$s' \geq -\bar{s}$$

where \bar{s} is a nonnegative constant. Maximization problem of employed household with current balances s and productivity level z can be represented by the following

Bellman equation:⁵

$$W_e(z, s) = \max_{c, s'} \left\{ u(c) + \beta \cdot \mathbb{E}_{z'|z} [(1 - \sigma \cdot (1 - f')) \cdot W_e(z', s') + \sigma \cdot (1 - f') \cdot W_u(z', s')] \right\} \quad (2)$$

subject to :

$$\begin{cases} c + s' = \frac{1+i}{\Pi} \cdot s + (1 - \tau) \cdot w \cdot z \\ s' \geq -\bar{s} \end{cases} \quad (3)$$

where W_e and W_u are value functions associated with the dynamic problem of employed and unemployed agent, respectively. Agents discount future utility streams with factor $\beta \in (0, 1)$. The maximization problem of unemployed household follows:

$$W_u(z, s) = \max_{c, s'} \left\{ u(c) + \beta \cdot \mathbb{E}_{z'|z} [f' \cdot W_e(z', s') + (1 - f') \cdot W_u(z', s')] \right\} \quad (4)$$

subject to :

$$\begin{cases} c + s' = \frac{1+i}{\Pi} \cdot s + \nu \cdot w \cdot z \\ s' \geq -\bar{s} \end{cases}$$

Euler inequalities associated with dynamic problems of employed and unemployed households are:

$$\begin{cases} u'(c_e) \geq \frac{1+i'}{\Pi'} \cdot \beta \cdot \mathbb{E}_{z'|z} [(1 - \sigma \cdot (1 - f')) \cdot u'(c'_e) + \sigma \cdot (1 - f') \cdot u'(c'_u)] \\ u'(c_u) \geq \frac{1+i'}{\Pi'} \cdot \beta \cdot \mathbb{E}_{z'|z} [f' \cdot u'(c'_e) + (1 - f') \cdot u'(c'_u)] \end{cases} \quad (5)$$

where c_e is consumption policy conditional on being employed and c_u corresponds to policy of the unemployed consumer.

⁵Observe that all quantities entering the maximization problem are expressed in real terms.

2.2 Retailers

The model is populated by perfectly competitive retailers who pack differentiated goods y_j , where $j \in [0, 1]$, into baskets of consumption goods y using technology described by the Dixit-Stiglitz aggregator:

$$y = \left(\int_0^1 y_j^{1-\frac{1}{\gamma}} dj \right)^{\frac{1}{1-\frac{1}{\gamma}}},$$

where $\gamma > 1$ is the elasticity of substitution between intermediate goods generated by firms. Retailers choose $\{y_j\}$ to maximize profits:

$$p \cdot y - \int_0^1 p_j y_j dj,$$

where p_j is price of variety produced by firm j . The following equation describes first order condition of the retailer is given by:

$$y_j = \left(\frac{p_j}{p} \right)^{-\gamma} \cdot y \quad (6)$$

where p equals:

$$p = \left(\int_0^1 p_j^{1-\gamma} dj \right)^{\frac{1}{1-\gamma}}.$$

2.3 Firms

There is a measure one of firms owned by households and indexed with $j \in [0, 1]$ that produce intermediate goods using linear technology with labor n being the only input. Firm j hires workers in the frictional labor market by posting vacancies v_j . The probability that vacancy is filled equals q which, similarly to f , is endogenous and depends on market tightness x . Proportion σ of existing jobs is destroyed between periods. Additionally, it is assumed that firm has to spend fixed cost $\xi > 0$ every period.⁶

For tractability, it is assumed that firms are not able to distinguish between more productive and less productive workers while recruiting them. Once the worker is hired, firm learns about his productivity and pays wage that is proportional to his

⁶Fixed cost is introduced to match the value of market capitalization of all firms observed in the data.

productivity level. This implies that the average productivity of workers employed in a firm is equal to $\mathbb{E}_z z$ where \mathbb{E}_z is an operator induced by the time-invariant distribution of workers across idiosyncratic productivity levels generated by the Markovian process. I standardize: $\mathbb{E}_z z = 1$. The assumption about unobservability of z during the recruitment process enables to combine the idiosyncratic income risk captured by changes in z with the Diamond-Mortensen-Pissarides specification of the labor market.

Firms are monopolistically competitive and set prices subject to quadratic price adjustment costs as in Rotemberg (1982) subject to demand for their products given by equation 6. Future profits are discounted with real interest rate $\frac{\Pi'}{1+i'}$ where Π is the ratio between the current price level and the one from the previous period.⁷

Firm j solves a dynamic problem of maximizing the discounted sum of real profits:

$$F(p_{j,-1}, n_{j,-1}) = \max_{p_j, v_j, n_j, y_j} \left\{ \frac{p_j}{p} \cdot y_j - \mathbb{E}_z (w \cdot z \cdot n_j) - \kappa \cdot v_j - \frac{\phi}{2} \left(\frac{p_j - p_{j,-1}}{p_{j,-1}} \right)^2 \cdot y - \xi + \frac{\Pi'}{1+i'} \cdot F(p_j, n_j) \right\} \quad (7)$$

subject to :

$$y_j = \mathbb{E}_z (z \cdot n_j)$$

$$y_j = \left(\frac{p_j}{p} \right)^{-\gamma} \cdot y$$

$$n_j = (1 - \sigma) \cdot n_{j,-1} + q \cdot v_j. \quad (8)$$

where $\phi > 0$ is a parameter, F is value function associated with the firm maximization problem, $p_{j,-1}$ is price set in the previous period, $n_{j,-1}$ is the number of workers employed in the previous period. First constraint describes production technology, second constraint captures the demand for goods produced by firm j and third describes the law of motion for employment in firm j .

⁷Observe that firms discount future profits with the real interest rate and not with the standard stochastic discount factor that is dependent on agents marginal utilities. The latter becomes problematic if agents exhibit heterogeneous asset holdings and consumption rates (see Gornemann et al. (2016) and Den Haan et al. (2015)). The simplification applied here makes the calibration exercise tractable and was used, for example, by Kaplan et al. (2016) and Hagedorn et al. (2017).

In the symmetric equilibrium, in which all firms are identical and hence subscripts j can be omitted, the first order condition that characterizes the optimal solution to problem 7 reads:

$$\begin{aligned} 1 - \gamma + w \cdot \gamma + \gamma \cdot \frac{\kappa}{q} - \frac{\Pi'}{1 + i'} \cdot \frac{\kappa \cdot (1 - \sigma) \cdot \gamma}{q'} \\ = \phi \cdot (\Pi - 1) \cdot \Pi - \frac{\Pi'}{1 + i'} \cdot \phi \cdot (\Pi' - 1) \cdot \Pi' \cdot \frac{y'}{y}. \end{aligned} \quad (9)$$

Finally, let us define the real value of firm's profits d :

$$d \equiv n - w \cdot n - \kappa \cdot v - \frac{\phi}{2} \cdot (\Pi - 1)^2 \cdot n - \xi. \quad (10)$$

2.4 Government

Government consists of two branches: fiscal authority and monetary authority. In stationary equilibrium, fiscal branch is assumed to run a balanced budget - i.e., it adjusts tax rate τ to finance purchases of manufactured goods G , expenditures on unemployment benefits and the cost of debt service:

$$n \cdot \tau \cdot w = (1 - n) \cdot \nu \cdot w + \frac{1 + i_{-1}}{\Pi} \cdot B - B' + G, \quad (11)$$

where B is the real value of bonds issued by government in the previous period. It is assumed that the level of government purchases in stationary equilibrium is equal to zero:

$$G_{ss} = 0.$$

Central bank sets the value of nominal interest rate $i \geq 0$ according to the following Taylor-type monetary policy rule:

$$i = \bar{i} + \phi_y \cdot \frac{y - y_{ss}}{y_{ss}} + \phi_{\Pi} \cdot (\Pi - \Pi_{ss})$$

where Π_{ss} and y_{ss} are values of Π and y in stationary equilibrium and \bar{i} , ϕ_y and ϕ_{Π} are parameters.

2.5 Wage-setting

Since there is no universal theory that would pin down wages in labor market featuring search frictions then, while analyzing stationary equilibrium, I assume that w is parameter that is set to match the calibration target presented in Section 3.⁸

2.6 Consistency Conditions

Market clearing condition for manufactured goods reads:

$$\int c_e(s, z) d\pi_e(s, z) + \int c_u(s, z) d\pi_u(s, z) + \kappa \cdot v + \frac{\phi}{2} \cdot (\Pi - 1)^2 \cdot y + G + \xi = y \quad (12)$$

where $c_e(s, z)$ and $c_u(s, z)$ are policy functions associated with dynamic problems of employed and unemployed households, respectively and by $\pi_e(s, z)$ I denote the measure of employed agents with asset holdings s and productivity z . An analogous object associated with unemployed households is denoted by $\pi_u(s, z)$. Market clearing condition for assets is:

$$\int s'_e(s, z) d\pi_e(s, z) + \int s'_u(s, z) d\pi_u(s, z) = B' + \frac{J' + d'}{\frac{1+i'}{\Pi'}}.$$

Notice that it is assumed that the aggregate number of shares is standardized to unity. Labor market tightness is given by the ratio of vacancies posted by firms and the pool of workers that do not have a job at the beginning of period:

$$x = \frac{v}{1 - (1 - \sigma) \cdot n_{-1}} \quad (13)$$

Observe that the pool of workers available to firms during the recruitment process (given by the denominator of 13) consists of workers who were unemployed in the previous period $1 - n_{-1}$ and those who worked but were fired at the beginning of the current period: σn_{-1} .

Probabilities f and q are induced by a constant returns to scale matching tech-

⁸Of course, w must be an element of bargaining set (see Hall (2005)) which is the case in the calibrated version of the model.

nology M , which generates new jobs by combining vacancies and jobless workers, and satisfy:

$$f(x) = \frac{M(v, 1 - (1 - \sigma) \cdot n_{-1})}{1 - (1 - \sigma) \cdot n_{-1}} = M(x, 1) \quad (14)$$

$$q(x) = \frac{M(v, 1 - (1 - \sigma) \cdot n_{-1})}{v} = M\left(1, \frac{1}{x}\right). \quad (15)$$

The law of motion of agents across states is characterized by two equations:

$$\begin{aligned} \pi_e(\mathcal{S}', z') &= (1 - \sigma \cdot (1 - f')) \cdot \int_{Z \times \{s: s'_e(s, z) \in \mathcal{S}'\}} \mathbb{P}(z'|z) d\pi_e(s, z) \\ &\quad + f' \cdot \int_{Z \times \{s: s'_u(s, z) \in \mathcal{S}'\}} \mathbb{P}(z'|z) d\pi_u(s, z) \end{aligned} \quad (16)$$

$$\begin{aligned} \pi_u(\mathcal{S}', z') &= \sigma \cdot (1 - f') \cdot \int_{Z \times \{s: s'_e(s, z) \in \mathcal{S}'\}} \mathbb{P}(z'|z) d\pi_e(s, z) \\ &\quad + (1 - f') \cdot \int_{Z \times \{s: s'_u(s, z) \in \mathcal{S}'\}} \mathbb{P}(z'|z) d\pi_u(s, z) \end{aligned} \quad (17)$$

where \mathcal{S}' is a Borel subset of $[-\bar{s}, +\infty)$, $\mathbb{P}(z'|z)$ is transition probability between states z and z' determined by the Markovian process which takes values in space Z . Equation 16 says that measure of employed workers in the next period with asset holdings in set \mathcal{S}' and productivity z' is composed of: i) currently employed households that have not been separated from their jobs and ii) currently unemployed workers that have got hired, who made asset choices that belong to \mathcal{S}' and whose productivity will take value z' in the next period. An analogous interpretation applies to 17 with the only difference that it aggregates currently employed workers that are separated from their jobs and those of currently unemployed that preserve their job status. Finally, it is required that:

$$\int d\pi_e(s, z) + \int d\pi_u(s, z) = 1, \quad (18)$$

i.e., the total measure of households equals one.

2.7 Stationary Equilibrium

Given the maximization problems of households and firms, government budget constraints, price-setting mechanisms and market clearing (and consistency) conditions,

we are in position to define the stationary equilibrium of the model:

Definition. *A stationary equilibrium is: positive numbers x , value functions W_e and W_u , policy functions c_e, c_u, s'_e, s'_u and probability distributions π_e, π_u such that given $\tau, \bar{b}, i, \Pi, w, d, J$ and B :*

- (a) Value functions solve household maximization problems given $f(x), \tau, \Pi, w, i$ and c_e, c_u, s'_e, s'_u are the associated policy functions,*
- (b) Numbers $q(x), \Pi, w, v, n, d$ satisfy equations 7-10 associated with firm's problem,*
- (c) Government budget constraint holds, $G = 0, B = B'$ and $i = \bar{i}$,*
- (d) Measures π_e and π_u are a fixed point of the dynamical system described by equations 16-18,*
- (e) Consistency conditions and market clearing conditions hold,*
- (f) Price J satisfies the no-arbitrage condition 1 and $\Pi = \Pi_{ss}$.*

The model does not allow for an analytic characterization and hence it has to be solved numerically. In the Appendix, I present an algorithm that computes the stationary equilibrium of the model.

3 Increase in Fiscal Purchases: Baseline Simulation

In this section, I calibrate the model and simulate the transitional path of main economic aggregates resulting from an unexpected, transitory change in government purchases.

3.1 Calibration

3.1.1 Functional Forms

First, let us specify the functional form of utility function u . It is assumed that it takes the following form:

$$u(c) = \frac{c^{1-\theta}}{1-\theta}$$

where θ is the rate of relative risk aversion. Second, let us concentrate on matching technology M . Following Ramey et al. (2000), I assume that M is specified as:

$$M(v, 1 - (1 - \sigma) \cdot n_{-1}) = \frac{v \cdot (1 - (1 - \sigma) \cdot n_{-1})}{(v^\alpha + (1 - (1 - \sigma) \cdot n_{-1})^\alpha)^{\frac{1}{\alpha}}}$$

where $\alpha > 1$.

3.1.2 Parameter Values

The time period is a quarter. Targets of my calibration are moments characterizing US economy in 2006 at the onset of the Great Recession. Model parameters can be divided into two groups. First of them contains parameters that are set with reference to the literature and second group is calibrated using the model to match moments observed in the data.

Parameters taken from the literature are: relative risk aversion θ , separation rate σ , replacement rate ν , parameters associated with the process governing exogenous productivity shocks, elasticity of substitution between intermediate goods γ , parameters associated with Taylor rule - ϕ_π and ϕ_y , price adjustment parameter ϕ and the lower bound on asset holdings \bar{s} . I set $\theta = 2$ which is a standard value in the literature. Following Shimer (2005), I set $\sigma = 0.057$ and $\nu = 0.4$. Similarly

Table 1: Parameters set with reference to the literature

Parameter	Description	Value	Source
θ	Relative risk aversion	2	Standard value
σ	Separation rate	0.057	Shimer (2005)
ν	Replacement rate	0.4	Shimer (2005)
ρ_z	Persistence of productivity shock	0.9674	Floden and Lindé (2001)
ϵ_z	Variance of productivity shock	0.0172	Floden and Lindé (2001)
γ	Elasticity of substitution between intermediate goods	11	Standard value
ϕ_Π	Taylor rule parameter (inflation)	1.5	Galí (2008)
ϕ_y	Taylor rule parameter (output gap)	0.125	Galí (2008)
ϕ	Price adjustment parameter	300	Hagedorn et al. (2017)
\bar{s}	Liquidity constraint	0	McKay and Reis (2016)

to Guerrieri and Lorenzoni (2011), I assume that the evolution of logs of idiosyncratic productivity z follows an AR(1) process with autocorrelation $\rho_z = 0.9674$ and variance $\epsilon_z = 0.0172$ chosen to match evidence documented by Floden and Lindé (2001). Next, I use the procedure constructed by Tauchen (1986) to approximate the AR(1) process by a discrete Markov chain and the associated space Z of its values consists of 12 points. I set $\gamma = 11$ to match the monopolistic markup equal to 10%. I assume that parameters associated with Taylor rule take standard, textbook values $\phi_\Pi = 1.5$ and $\phi_y = 0.125$. I follow Hagedorn et al. (2017) and set $\phi = 300$. Finally, I follow McKay and Reis (2016) and Krueger et al. (2016) and standardize the liquidity constraint \bar{s} to 0. Calibrated parameter values of $\theta, \sigma, \mu, \rho_z, \epsilon_z, \gamma, \phi_\Pi, \phi_y, \phi, \bar{s}$ are summarized in Table 1.

Matching the moments generated by the model with their empirical counterparts allows us to pin down the remaining parameter values. As in Guerrieri and Lorenzoni (2011), I assume that the steady state value of the annual real interest rate equals 2.5% and is targeted by β . Since I consider a stationary equilibrium in which $\Pi = 1$ the value of \bar{i} equals 2.5%, too. Real wage w is adjusted to match the unemployment rate U equal to 5% where:

$$U \equiv 1 - n.$$

As in Hagedorn and Manovskii (2008), parameter α characterizing matching in labor market is calibrated so that quarterly vacancy filling rate in the model q equals

Table 2: Parameters calibrated with the model

Parameter	Description	Value	Target
β	Discount factor	0.97	Real interest rate
\bar{i}	Nominal interest rate in s.s.	$(1 + 0.025)^{\frac{1}{4}} - 1$	Annual real rate of 2.5%
w	Real wage	0.76	Unemployment rate
α	Parameter associated with function M	3.74	Quarterly vacancy filling rate 97.6%
κ	Vacancy posting cost	0.12	Ratio between recruitment costs and wages as in Silva and Toledo (2009)
B	Aggregate supply of bonds	2.32	Ratio between liquid assets and GDP
ξ	Fixed cost	0.014	Market capitalization - GDP ratio

97.6%. Parameter κ is chosen to match the ratio between recruitment costs spent on each hired and worker's wage reported by Silva and Toledo (2009) that equals 0.14 for quarterly labor earnings. I set the steady state value of government bonds B to match the ratio between public debt and annual GDP equal to 0.61. Tax rate τ is set to balance government budget. The calibration target of fixed cost ξ is the ratio of market capitalization of US companies and annual GDP equal to 1.41.

3.2 Increase in Government Purchases

In this section I study the effects of an unexpected, transitory increase in government purchases G . First, I discuss the modifications that need to be introduced into the stationary version of the model presented in Section 2 to study the dynamic impact of the rise in fiscal consumption. Second, I present simulation results.

3.2.1 Transitional Dynamics: Technical Issues

It is assumed that economy is in stationary equilibrium in period $t = 0$. In period $t = 1$ there is an unexpected increase in government purchases which rise from zero at $t = 0$ to 1% of the stationary equilibrium level of GDP at $t = 1$. For $t > 1$, government spending is governed by autoregressive process and decays at rate 0.8. I assume that for $t > 1$ agents have perfect foresight about evolution of aggregate variables. As $t \rightarrow +\infty$, economy converges back to its initial allocation from period

$t = 0$. In practice, it is assumed that economy is back in the stationary equilibrium in period $t = \bar{T}$ where \bar{T} is sufficiently large.

While analyzing the transitional dynamics, I assume a perfect degree of indexation of nominal wages to the price level associated with manufactured goods which implies that real wages are constant over time. This formulation resembles the specification of the process governing real wages in works by Michaillat (2012) and Blanchard and Galí (2010) who assume that w co-moves with aggregate productivity. As the latter remains unchanged in my simulation then it implies that the average real wage does not change either.

Finally, in the baseline simulation I assume that increase in G is financed with taxes τ and hence B remains constant over time. I will analyze the situation in which higher government purchases are covered with a rise in B in Section 5.

Endogenous Grid Method (see Carroll (2006)) is applied to solve the model and to compute transitional dynamics. More details on the solution algorithm are provided in the Appendix.

3.2.2 Simulation Results

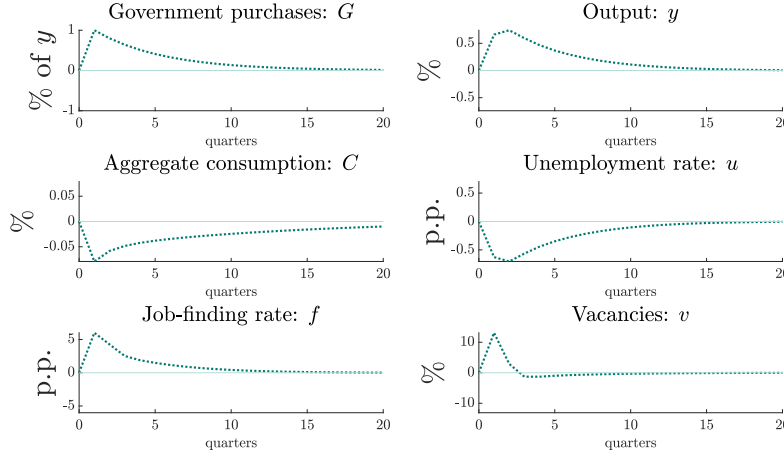
Aggregate consumption, which is the main object of interest in my analysis is defined as:

$$C \equiv \int c_e(s, z) d\pi_e(s, z) + \int c_u(s, z) d\pi_u(s, z).$$

Figure 1 displays the impact of the rise in government purchases on main economic variables. First, notice that output increases less than one-for-one with G - the multiplier in period $t = 1$ is equal to 0.98. It does not exceed unity because aggregate consumption C drops by about 0.1% at $t = 1$ and this negative impact on output is not mitigated by the simultaneous rise in job creation $\kappa \cdot v$ and the growth in price adjustment cost which contribute to the economy-wide aggregate demand according to equation 12. Observe that higher government expenditures lead to a substantial decrease in unemployment rate which drops by almost 0.7 percentage points - a value that is not very far from the VAR estimates reported by Monacelli et al. (2010).

Let us analyze the behavior of two additional variables associated with labor market: v and f that are reported in the bottom row of Figure 1. Intuitively, transitory fiscal expansion raises current and future aggregate demand which spurs job

Figure 1: Impulse response functions, main aggregate variables, deviations from stationary equilibrium values, baseline simulation.



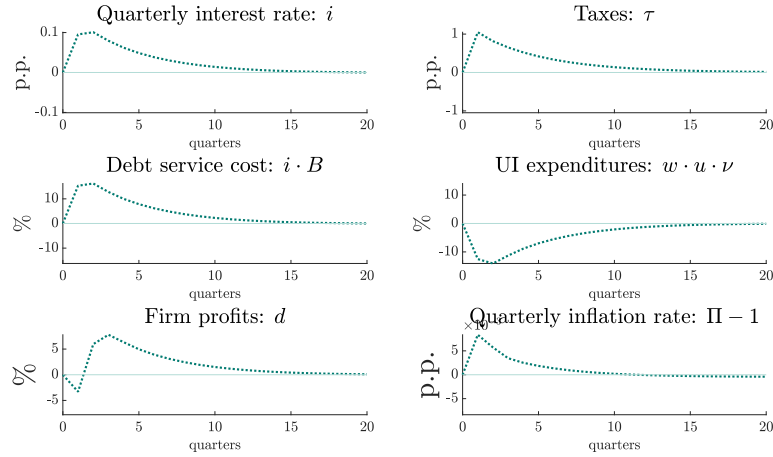
creation across firms when price rigidities are in place. This process is particularly intense at the beginning of fiscal expansion as rational firms anticipate the future drop in the pool of jobless workers and the associated rise in effective recruitment costs in the future, which is captured by lower vacancy filling rate q (which mirrors the behavior of f), and hence they choose to intensify hiring activities in period $t = 1$ when this pool is relatively large.⁹ The rapid increase in vacancy posting at the beginning of fiscal intervention explains the spike in the job-finding rate at $t = 1$.

Variables associated with monetary and fiscal policy are presented in Figure 2. Fiscal intervention leads to a sharp increase in nominal interest rates (by about 0.4 percentage points in annual terms). This reflects the reaction of monetary authority to the rise in output and inflation prescribed by the Taylor rule. Higher nominal interest rates elevate real rates and thus strengthen incentives to save and to cut consumption. Additionally, fiscal stimulus leads to a 1.05 percentage point growth in tax rate τ that crowds out private consumption even further.

It is instructive to study the determinants of changes in τ . Except for adjusting to higher level of G , there are several additional forces that shape the response of labor

⁹Putting differently, firms intensify recruitment when labor market tightness is relatively low.

Figure 2: Impulse response functions, fiscal and monetary variables, deviations from stationary equilibrium values, baseline simulation.



tax. On the one hand, higher quarterly nominal interest rate, raises debt service cost $i \cdot B$. This reflects an interaction between fiscal and monetary policy during which the latter leans against the former and, as a result, decreases its effectiveness. Higher debt service costs impose an upward pressure on tax rate τ - see equation 11. On the other hand, by decreasing employment fiscal expansion has two effects that tend to lower tax rate τ : i) higher employment means that labor tax base $w \cdot n$ is larger which induces lower rates τ and ii) the increase in n lowers government expenditures associated with unemployment benefits imposing, again, a downward pressure on τ . They do not, however, overweight the impact of a rise in government consumption and debt service costs on τ .

Since the rise in government purchases stimulates aggregate demand then we observe higher inflation that grows by 0.4 percentage points at the peak (in annual terms).

4 Employment Prospects Channel

Let us turn to the main exercise of the paper which aims at isolating the employment prospects channel - the mechanism through which better job perspectives during fiscal expansion improve consumer confidence, reduce precautionary motives and, as a result, stimulate private expenditures.

First, let us discuss the consumption decomposition method more generally. Observe that aggregate consumption in period $t > 0$ can be totally differentiated with respect to elements of set \mathcal{X}_t of all endogenous variables which appear in the maximization problems 2 and 4 in period $\tilde{t} > 0$.¹⁰

$$dC_t = \sum_{\tilde{t}=1}^{+\infty} \sum_{x_{\tilde{t}} \in \mathcal{X}_{\tilde{t}}} \frac{\partial C_t}{\partial x_{\tilde{t}}} \cdot dx_{\tilde{t}} \quad (19)$$

where:

$$\mathcal{X}_{\tilde{t}} = \{w_{\tilde{t}}, \Pi_{\tilde{t}}, \tau_{\tilde{t}}, f_{\tilde{t}+1}, i_{\tilde{t}}\}.$$

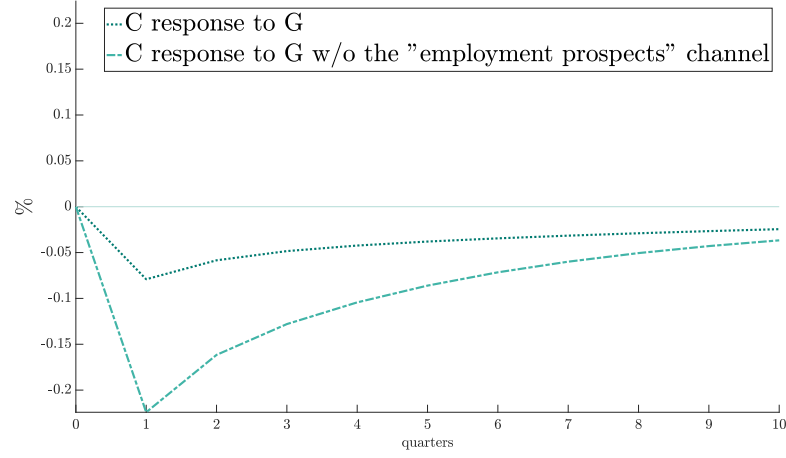
Thus, formula 19 allows decomposition of the response of aggregate consumption into channels which have a clear, model-based interpretation. In particular, element $\sum_{\tilde{t}=1}^{+\infty} \frac{\partial C_t}{\partial f_{\tilde{t}+1}} df_{\tilde{t}+1}$ is given by:

$$\sum_{\tilde{t}=1}^{+\infty} \frac{\partial C_t}{\partial f_{\tilde{t}+1}} df_{\tilde{t}+1} = \sum_{\tilde{t}=1}^{+\infty} \frac{\partial}{\partial f_{\tilde{t}+1}} \left\{ \sum_{a \in \{e, u\}} \int c_{a,t}(s, z) d\pi_{a,t}(s, z) \right\} df_{\tilde{t}+1}.$$

and can be interpreted as the accumulated effect of variation in the transition path of job-finding rates $\{f_{\tilde{t}+1}\}_{\tilde{t}=1}^{+\infty}$ on aggregate consumption in period t . Notice that the formula above does not isolate the impact of employment prospects on aggregate consumption as it fails to eliminate the effect of job-finding rate f on the composition of agents (employed and unemployed workers) which works through the evolution of the aggregate distribution of households captured by equations 16 and 17 and which has no forward-looking character. Nevertheless, $\sum_{\tilde{t}=1}^{+\infty} \frac{\partial C_t}{\partial f_{\tilde{t}+1}} df_{\tilde{t}+1}$ can be decomposed further into two parts:

¹⁰This is a discrete time version of the procedure described in Kaplan et al. (2016).

Figure 3: Employment prospects channel, baseline simulation.



$$\begin{aligned}
 \sum_{\tilde{t}=1}^{+\infty} \frac{\partial C_t}{\partial f_{\tilde{t}+1}} \cdot df_{\tilde{t}+1} &= \underbrace{\sum_{\tilde{t}=1}^{+\infty} \sum_{a \in \{e, u\}} \left(\int c_{a,t}(s, z) \cdot \left\{ \frac{\partial}{\partial f_{\tilde{t}+1}} \tilde{\pi}_{a,t}(s, z) \right\} ds dz \right) \cdot df_{\tilde{t}+1}}_{\text{"Compositional" channel}} \\
 &+ \underbrace{\sum_{\tilde{t}=1}^{+\infty} \sum_{a \in \{e, u\}} \left(\int \left\{ \frac{\partial}{\partial f_{\tilde{t}+1}} c_{a,t}(s, z) \right\} \cdot \tilde{\pi}_{a,t}(s, z) ds dz \right) \cdot df_{\tilde{t}+1}}_{\text{"Employment prospects" channel}}. \quad (20)
 \end{aligned}$$

where $\tilde{\pi}$ is the density function associated with measure π .¹¹ “Compositional” channel describes forces that affect aggregate consumption via changes in the distribution of workers. They are associated with i) changes in the distribution driven directly by shifts in job market status and ii) the impact of changes in path of job-finding rates on past consumption decisions and the associated asset accumulation policies which, in turn, shape current distribution of net worth. “Employment prospects” channel, instead, measures the effects of variation in job finding rates on consumption decision of agents aggregated over an unchanged, steady-state, distribution of agents.

Since formula 20 does not exclude a possibility that $t > \tilde{t}$ then it may appear that the second component captures the impact of past job finding rates on current

¹¹For tractability and for notational purposes, I assume that $\tilde{\pi}$ exists.

aggregate consumption which, in turn, would mean that its name - “employment prospects” channel is not adequate. To see why it is not the case, observe that since the optimization problems are forward looking then:¹²

$$\frac{\partial}{\partial f_{\tilde{t}+1}} c_{a,t}(s, z) = 0 \text{ for } \tilde{t} < t.$$

This implies that:

$$\begin{aligned} & \sum_{\tilde{t}=1}^{+\infty} \sum_{a \in \{e, u\}} \left(\int \left\{ \frac{\partial}{\partial f_{\tilde{t}+1}} c_{a,t}(s, z) \right\} \cdot \tilde{\pi}_{a,t}(s, z) ds dz \right) \cdot df_{\tilde{t}+1} \\ &= \sum_{\tilde{t} \geq t}^{+\infty} \sum_{a \in \{e, u\}} \left(\int \left\{ \frac{\partial}{\partial f_{\tilde{t}+1}} c_{a,t}(s, z) \right\} \cdot \tilde{\pi}_{a,t}(s, z) db dz \right) \cdot df_{\tilde{t}+1} \end{aligned}$$

which shows that second component in formula 20 captures solely the impact of future job-finding rates on private consumption. This means that its name - “employment prospects channel” - is justified.

Notice, that hand-to-mouth agents, which are at the root of powerful effects of fiscal and monetary policies in numerous models with heterogeneous households (see, for instance, Kaplan et al. (2016), Oh and Reis (2012)), are not affected by the channel studied here. It is because their behavior is described by the corner solution to problems 2 and 4, where constraint $s' \geq -\bar{s}$ is binding and hence the value of their consumption ceases to be determined by the Euler equation (that depends on future job-finding rate f') and, instead, is driven solely by changes in available resources.

From the numerical point of view, the “unemployment prospects” component is calculated by performing the “backward iteration” with all variables from set $\mathcal{X}_{\tilde{t}}$ taking their steady state values - except for the path of job finding rates which takes values calculated in Section 3. Then, using calculated policies, I perform the “forward iteration” and, at the same time, I keep the distribution of agents equal to its stationary equilibrium value. The procedures of “backward” and “forward” iterations are described in the Appendix.

¹²Formally, policy function $c_{a,t}$ depends on individual state variables b, z and the vector of aggregate state variables π_e, π_u, p_{-1} and n_{-1} . Dependence on the latter is omitted in the text for clarity.

Figure 3 displays the response of aggregate consumption which has been already presented in Figure 1 together with the hypothetical path of household spending when employment prospects channel is closed. More precisely, elements of the latter are defined as:

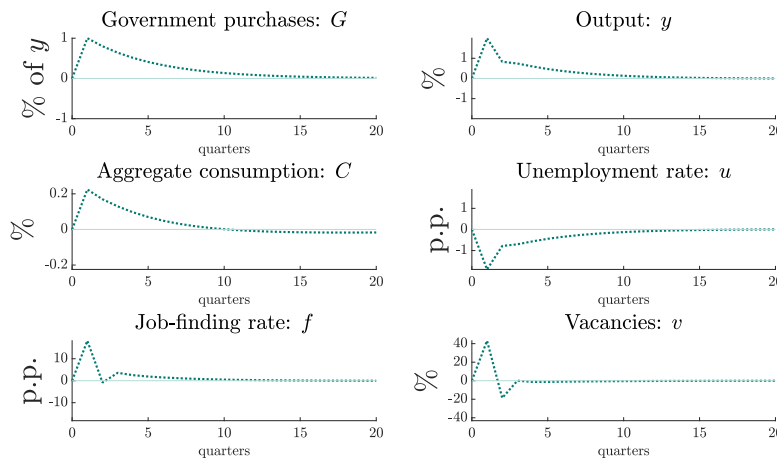
$$C_t - \sum_{\tilde{t} \geq t}^{+\infty} \sum_{a \in \{e, u\}} \left(\int \left\{ \frac{\partial}{\partial f_{\tilde{t}+1}} c_{a,t}(s, z) \right\} \cdot \tilde{\pi}_{a,t}(s, z) ds dz \right) \cdot df_{\tilde{t}+1}.$$

Figure 3 indicates, that the magnitude of the analyzed channel is significant. In particular, a drop in aggregate consumption associated with fiscal stimulus in period $t = 1$ is about three times larger when the role of employment prospects is ignored.

5 Increase in Fiscal Purchases: two alternative scenarios

In this part, I verify the robustness of the finding concerning the magnitude of the employment prospects channel by analyzing its importance under two additional scenarios. First, I consider the case in which monetary policy is unresponsive to changes in macroeconomic environment which is formalized by changing the value of parameters ϕ_y and ϕ_Π to 0. This variant is motivated by a large literature studying the effects of government purchases when monetary policy is constrained by the zero lower bound on nominal interest rates which, automatically, implies that monetary policy does not react to changes in G (see, e.g., Eggertsson (2011) and Woodford (2011)). Second scenario studies an alternative way of financing fiscal expansion which is based on an increase in government debt B instead of the rise in taxes τ during the first year of intervention.

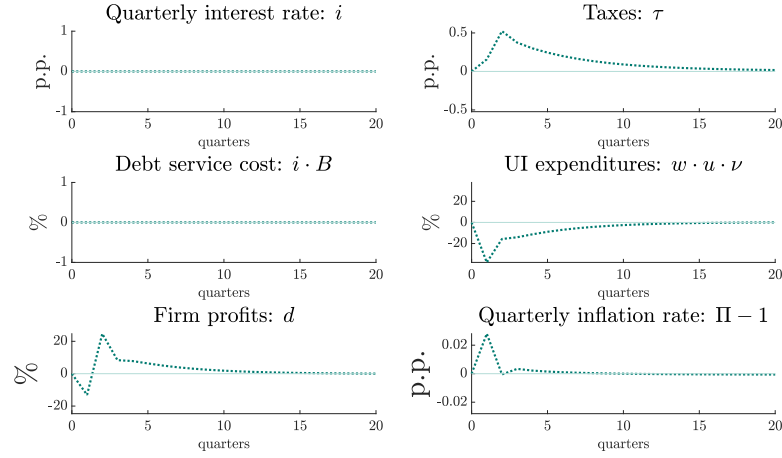
Figure 4: Impulse response functions, main aggregate variables, deviations from stationary equilibrium values, simulation assumes $\phi_y = 0$ and $\phi_\Pi = 0$.



5.1 Unresponsive monetary policy

Figure 4 shows the effects of an increase in government expenditures on main economic variables when monetary policy rule is modified by setting $\phi_y = 0$ and $\phi_\Pi = 0$.

Figure 5: Impulse response functions, fiscal and monetary variables, deviations from stationary equilibrium values, simulation assumes $\phi_y = 0$ and $\phi_\Pi = 0$.

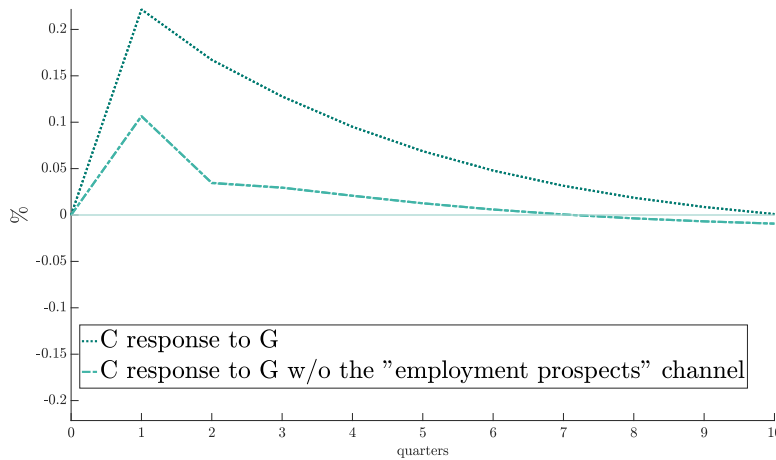


Output rises more than one-for-one with G mainly due to the fact that, in contrast to the baseline scenario, aggregate consumption grows during fiscal expansion. The resulting drop in unemployment is deeper and it equals 1.5 percentage points on impact. Notice that the rise in aggregate demand that is driven by both higher G and C creates stronger incentives to expand output capacity by creating new jobs than in the baseline case which is captured by a more dynamic increase in posted vacancies v and in job finding rate f .

To understand the behavior of aggregate consumption, it is useful to analyze changes in nominal interest rates and taxes which are displayed in Figure 5.

Observe, that since monetary policy does not react neither to the positive change in output gap nor to the spike in inflation, then the path of nominal interest rates remains constant over time. This implies, that the intertemporal substitution effects spurred by monetary policy, which strengthen saving incentives, vanish. This, in turn, mitigates the downward pressure of higher nominal rates on aggregate consumption present in the baseline case.

Let us turn to the behavior of tax rate τ . Again, its value grows only by a half of the rise in τ calculated in the previous scenario. To understand the difference, observe that in contrast to the case in which monetary policy follows the Taylor Rule, the situation that assumes constant interest rates implies the unchanged level of debt service costs that eliminates one source of an upward pressure on tax τ during fiscal

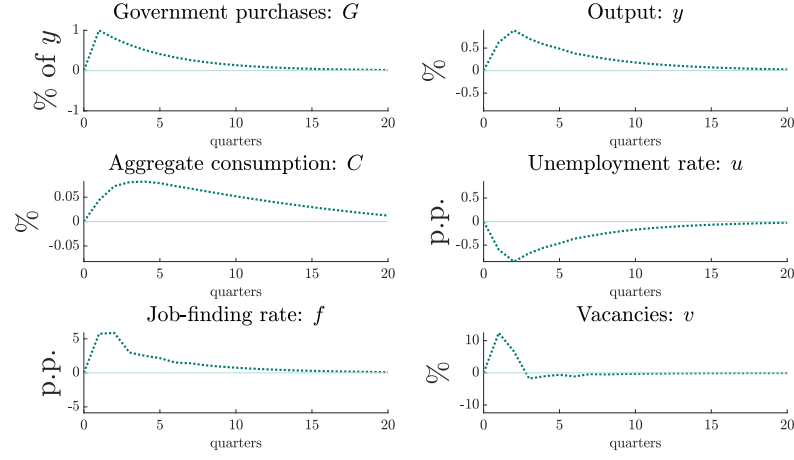
Figure 6: Employment prospects channel, simulation assumes $\phi_y = 0$ and $\phi_\Pi = 0$.

expansion. On top of that, due to a more pronounced decrease in unemployment, transfers to jobless households drop and the labor tax base expands, which reduces the rise in rates τ even further.

Summing up, a less intensive increase in i and τ when $\phi_y = 0$ and $\phi_\Pi = 0$ is the main cause of the switch in the sign of aggregate consumption response to fiscal expansion with respect to baseline scenario. Notice that higher private demand stimulates output, job creation, improves employment prospects which, in turn, boosts private consumption even further, etc. Thus, a reduction in growth of i and τ sets in motion a feedback loop of general equilibrium effects which generate a substantial difference between the results of fiscal policy under different monetary regimes.

Finally, let us investigate the role of employment prospects channel when monetary policy remains idle during fiscal expansion. Results of the simulation are presented in Figure 6. It turns out that once the improvement in job prospects is ignored, response of aggregate consumption to higher government purchases is reduced by more than 50%. This outcome underscores a prominent role of job prospects in the propagation of fiscal stimulus packages and shows that the analyzed channel is robust to changes in the assumption about monetary policy rule.

Figure 7: Impulse response functions, main aggregate variables, deviations from stationary equilibrium values, debt financed government purchases.



5.2 Debt-financed stimulus

Let us study the effects of the stimulus financed with an increase in government debt. Using the same, autoregressive path of government spending $\{G_t\}_{t=1}^{\bar{T}}$ as in two previous cases, I set the path of real public debt $\{B_t\}_{t=1}^{\bar{T}}$ so that it satisfies:

$$\begin{cases} B_{t+1} = B_{ss} + \sum_{s=1}^t G_s & \text{for } 0 < t \leq t' \\ B_{t+1} = B_{ss} + \left(1 - \frac{t-t'}{t''-t'}\right) \cdot \sum_{s=1}^{t'} G_s & \text{for } t' < t \leq t'' \\ B_{t+1} = B_{ss} & \text{for } t'' < t \leq \bar{T}. \end{cases}$$

In other words, from period $t = 1$ to period $t = t'$, increase in government expenditures is completely absorbed by public debt. Next, between periods t' and t'' , the initial increase in government debt is reduced to its steady state level (I assume a linear pace of downward adjustment). For periods $t > t''$ onward, the real value of public debt is identical to B_{ss} .

In the simulations, I set $t' = 4$ and $t'' = 40$: the stimulus is financed entirely with public debt during the first year and then, the additional debt issued at the beginning is repaid within 10 years from the onset of expansion. Clearly, we need to guarantee that government budget constraint is satisfied for each period $t \in \{1, 2, \dots, \bar{T}\}$ and hence τ adjusts to balance the budget.

Figure 8: Impulse response functions, fiscal and monetary variables, deviations from stationary equilibrium values, debt financed government purchases.

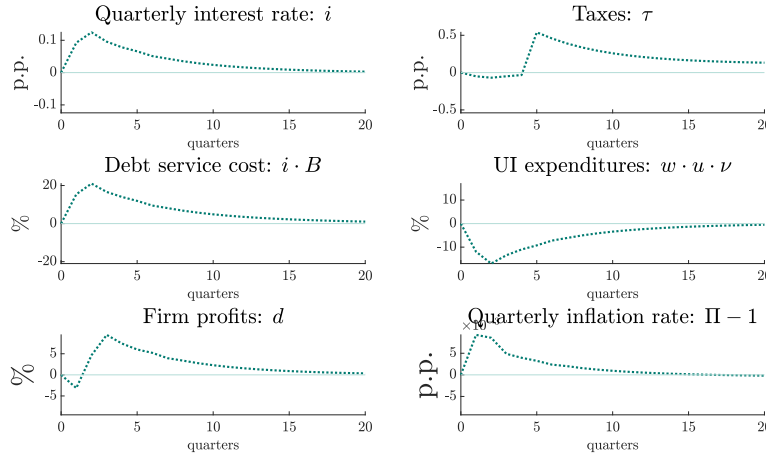
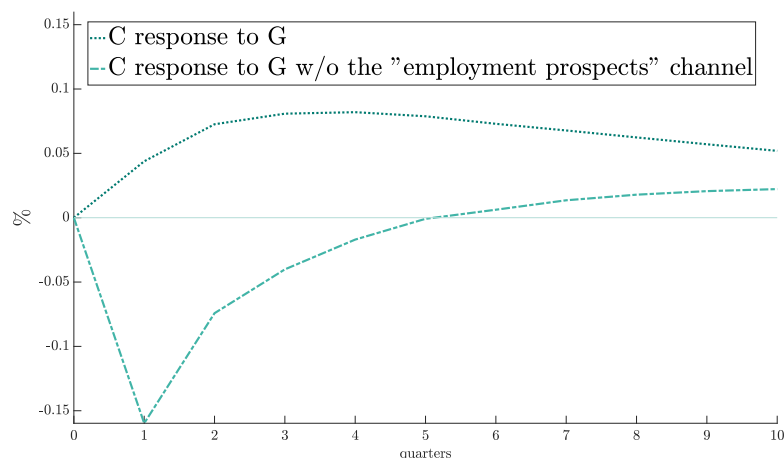


Figure 7 displays the impact of a rise in government purchases on main economic aggregates when B follows the path described above.

It is crucial to understand the reasons for which the response in aggregate consumption becomes positive when fiscal stimulus is financed with debt in the first year of expansion. As it has been observed by Hagedorn et al. (2017), negative reaction of private spending in the baseline case is not very surprising given the fact that rising taxes τ affects income of all workers. In particular, higher taxes have an impact on those with low levels of wealth who exhibit high MPC and thus they decrease their consumption significantly. The situation is very different when higher G is financed with a rise in B . First, higher debt enables to reduce tax rate τ (see the top right panel of Figure 8) and hence the adverse effects of τ on incomes of high MPC workers is mitigated. Second, the newly issued debt is mainly bought by low MPC workers whereas high MPC households consume additional income generated by the stimulus. In other words, deficit financed expansion leads to an implicit redistribution from asset-rich workers, who exhibit low MPC and whose main source of financing expenditures is asset income, to low-asset households with high MPC who rely more on labor income that, through changes in labor market status, is highly dependent on job creation that takes place during fiscal expansion.

Notice that, similarly to baseline scenario, the response of monetary policy is relatively aggressive and leads to a rise in nominal interest rates by 0.5 percentage

Figure 9: Employment prospects channel, debt financed government purchases.



points (in annual terms) at the peak. First, this process results in stronger incentives to save which imposes a downward pressure on consumption. Second, it elevates the cost of debt service cost and leads to higher taxes. Independently, debt service costs increase automatically because B is raised in this scenario.

Observe that higher C in comparison to the baseline simulation leads to higher job creation and larger reduction in unemployment risk captured with the inverse of f . This, in turn, leads to additional multiplier effects between better employment prospects and private demand which reduce the drop in C and raise f even further in comparison to the benchmark.

Figure 9 displays the role of employment prospects channel when G is financed with debt. It turns out that the response of private consumption becomes negative if the mechanism is ignored. The magnitude of the channel is larger than in baseline scenario because the reaction of job finding probability to change in G is stronger.

6 Conclusions

This paper has analyzed and quantified a channel which propagates the effects of fiscal purchases through improvement in job prospects. To this end, I have used an extended version of the Bewley-Huggett-Aiyagari (BHA) with frictional labor and sticky prices. Baseline simulation indicates that the role of employment prospects channel for the effectiveness of fiscal expenditures is substantial: a hypothetical scenario in which the channel is shut off predicts a rise crowding out of private consumption that is three times larger.

To verify the robustness of this finding, I have analyzed two additional scenarios: the one in which monetary policy is unresponsive to changes in output gap and inflation and the second in which expansion in fiscal purchases is financed with debt. The results of those simulations corroborate the finding from the baseline scenario: the role of employment prospects is a crucial force shaping the aggregate consumption response to change in government purchases.

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Appendix

Solution Algorithm: Stationary Equilibrium

Steps:

1. Guess \bar{i} . Note, that \bar{i} pins down the steady state value of real interest rate in stationary equilibrium for which $\Pi = 1$.
2. For a given \bar{i} :
 - (a) Compute q from 9.
 - (b) Given q compute x from 15 and f from 14 given x . Then, use the fact that $q \cdot v = M(v, 1 - (1 - \sigma) \cdot n)$ (equation 15) to reformulate the stationary version of equation 8 to get:

$$\sigma \cdot n = M(v, 1 - (1 - \sigma) \cdot n)$$

and divide by $1 - (1 - \sigma) n$ to get (the CRS property of M works here):

$$\frac{\sigma \cdot n}{1 - (1 - \sigma) n} = M(x, 1)$$

so given x we are able to obtain n . Take n, q to derive v from the equilibrium condition concerning the job market flows:

$$\sigma \cdot n = q \cdot v.$$

- (c) Given Π, n and v compute firm's profits d from 10.
- (d) Given d, \bar{i} and Π , use 1 to get price J and compute the total supply of assets:

$$S_{supply} = B + \frac{J + d}{\frac{1 + \bar{i}}{\Pi}}$$

- (e) Given $n, d, \Pi, G = 0$ and parameters B, \bar{i} derive τ from 11.
- (f) We are in position to use the EGM method to obtain policy functions $\{c_u(s, z)\}_{s,z}$ and $\{c_e(s, z)\}_{s,z}$ as we have already calculated all endogenous variables that are taken as given by households: $f' = f, \Pi, \tau$ and $i = \bar{i}$.

- (g) Use $\{c_u(s, z)\}_{s,z}$, $\{c_e(s, z)\}_{s,z}$ and household budget constraints to derive $\{s'_u(s, z)\}_{s,z}$ and $\{s'_e(s, z)\}_{s,z}$. Use them together with $f' = f$ to compute the fixed point of the dynamical system that consists of 16 and 17: measures $\{\pi_e(s, z)\}_{s,z}$, $\{\pi_u(s, z)\}_{s,z}$.
- (h) Given $\{s'_u(s, z)\}_{s,z}$ and $\{s'_e(s, z)\}_{s,z}$ and $\{\pi_e(s, z)\}_{s,z}$, $\{\pi_u(s, z)\}_{s,z}$ calculate households' demand for liquid assets:

$$S_{demand} = \int s'_e(s, z) d\pi_e(s, z) + \int s'_u(s, z) d\pi_u(s, z).$$

3. Use the following formula:

$$\bar{i}^{new} = \bar{i} - \epsilon \cdot (S_{demand} - S_{supply})$$

where ϵ is a small positive number. The idea is that if demand for liquid assets calculated for \bar{i} exceeded the number S_{supply} then to move towards equilibrium in which $S_{demand} = S_{supply}$ we need to disincentivize households from saving. This is done by decreasing \bar{i} which reduces the real interest rate. Finally, replace \bar{i} with \bar{i}^{new} . Iterate until convergence - i.e. when $|S_{demand} - S_{supply}|$ is sufficiently small.

Solution Algorithm: Transition

I will discuss the procedure which is used to compute the transitional dynamics of the model.

1. Set a sufficiently large number \bar{T} (the end of the transition - economy is assumed to be back in the stationary equilibrium in period \bar{T}) and set $\{c_{u,\bar{T}}(s, z)\}_{s,z} = \{c_u(s, z)\}_{s,z}$, $\{c_{e,\bar{T}}(s, z)\}_{s,z} = \{c_e(s, z)\}_{s,z}$, $\Pi_{\bar{T}} = 1$, $f_{\bar{T}} = f_{ss}$, $q_{\bar{T}} = q_{ss}$, $J_{\bar{T}} = J_{ss}$ and $d_{\bar{T}} = d_{ss}$. Set the initial distribution of agents across nominal wealth and productivity $\{\pi_{e,1}(s, z)\}_{s,z} = \{\pi_e(s, z)\}_{s,z}$ and $\{\pi_{u,1}(s, z)\}_{s,z} = \{\pi_u(s, z)\}_{s,z}$. Guess the paths of: price ratios $\{\Pi_t\}_{t=1}^{\bar{T}-1}$, interest rates $\{i_t\}_{t=1}^{\bar{T}}$, employment $\{n_t\}_{t=1}^{\bar{T}}$ and auxiliary path of prices $\{p_t\}_{t=1}^{\bar{T}}$ which satisfies $\Pi_t = \frac{p_t}{p_{t-1}}$. It is introduced to improve the convergence properties of the algorithm as guessing the path $\{\Pi_t\}_{t=1}^{\bar{T}-1}$ did not lead to successful calculations. The reason is that p_t affects both the rate Π_t that determines the value of households

wealth via holdings b_t and the real interest rate $\frac{1+i'}{\Pi'}$ that governs consumption/savings decisions in period t . Ratio Π_t affects only one of those values in a given period. Using the postulated AR(1) process and the initial value $G_1 = 0.01 \cdot y_{ss}$ compute the path of real government expenditures $\{G_t\}_{t=1}^{\bar{T}}$. Finally, guess $\{S_{supply,t}\}_{t=1}^{\bar{T}}$ and set $\{S_{supply,t}^{new}\}_{t=1}^{\bar{T}}$ differs from $\{S_{supply,t}\}_{t=1}^{\bar{T}}$ significantly.

2. For $t = \bar{T} - 1$ back to $t = 1$:
 - (a) Given Π_{t+1} , Π_t , q_{t+1} , i_{t+1} , $y_{t+1} = n_{t+1}$ and $y_t = n_t$ compute q_t from 9.
 - (b) Given q_t compute x_t from 15 and f_t from 14 given x_t . Use q_t and the guessed values of n_t and n_{t-1} to obtain v_t from 8.
 - (c) Use 10 and v_t and guessed values of n_t and Π_t to compute d_t .
 - (d) Given J_{t+1} , d_{t+1} , Π_{t+1} , i_{t+1} derive J_t from the no-arbitrage condition.
 - (e) Use guessed values of n_t , i_t , Π_t and computed d_t to get τ_t from 11.
 - (f) BACKWARD ITERATION: We are in position to use equations/inequalities 5 and budget constraints from 2 and 4 and to apply the EGM procedure to derive $\{c_{u,t}(s, z)\}_{s,z}$ and $\{c_{e,t}(s, z)\}_{s,z}$. It is because we have either derived or guessed all endogenous variables that are taken as given by households: i_t , f_{t+1} , Π_t , τ_t and we know $\{c_{u,t+1}(s, z)\}_{s,z}$ and $\{c_{e,t+1}(s, z)\}_{s,z}$.
3. For $t = 1$ to $t = \bar{T} - 1$ (FORWARD ITERATION):
 - (a) Given $\{\pi_{e,t}(s, z)\}_{s,z}$, $\{\pi_{u,t}(s, z)\}_{s,z}$ and f_t compute the distribution of agents after labor market shocks (i.e., after separations and job finding) which take place at the beginning of the period and before agents make their consumption/saving choices. Denote those distributions by $\{\tilde{\pi}_{e,t}(s, z)\}_{s,z}$, $\{\tilde{\pi}_{u,t}(s, z)\}_{s,z}$. Integrate to obtain n_t :

$$n_t = \sum_{s,z} \{\tilde{\pi}_{e,t}(s, z)\}_{s,z}.$$

It becomes the new guess for n_t in further iterations.

- (b) Given $\{c_{u,t}(s, z)\}_{s,z}$ and $\{c_{e,t}(s, z)\}_{s,z}$ and budget constraints derive $\{s_{u,t+1}(s, z)\}_{s,z}$ and $\{s_{e,t+1}(s, z)\}_{s,z}$. Combine them with $\{\tilde{\pi}_{e,t}(s, z)\}_{s,z}$, $\{\tilde{\pi}_{u,t}(s, z)\}_{s,z}$ to

derive $\{\pi_{e,t+1}(s, z)\}_{s,z}$, $\{\pi_{u,t+1}(s, z)\}_{s,z}$ and to obtain the aggregate demand for liquid assets in period t :

$$S_{demand,t} = \int s_{e,t+1}(s, z) d\tilde{\pi}_{e,t}(s, z) + \int s_{u,t+1}(s, z) d\tilde{\pi}_{u,t}(s, z).$$

4. If the value $|S_{demand,t} - S_{supply,t}^{new}|$ is not sufficiently small for all t then for each $t \in \{1, 2, \dots, \bar{T} - 1\}$ calculate:

- (a) An new guess of the artificial and auxiliary object p_t :

$$p_t^{new} = p_t - \epsilon \cdot (S_{demand,t} - S_{supply,t}^{new}).$$

The idea is that if the demand for assets is too large in comparison to supply then we need to discourage agents from saving by lowering the price level p_t so that they consume more. Replace p_t with p_t^{new} .

- (b) Use $\Pi_t = \frac{p_t}{p_{t-1}}$ to derive the new guess for the price ratio in period t .

- (c) Use Taylor rule to modify the guess for i_t .

5. If the value $|S_{demand,t} - S_{supply,t}^{new}|$ is sufficiently small for each $t \in \{1, 2, \dots, \bar{T} - 1\}$ and $|S_{supply,t}^{new} - S_{supply,t}|$ is not sufficiently small for all t then for each $t \in \{1, 2, \dots, \bar{T} - 1\}$ calculate:

$$S_{supply,t} = S_{supply,t}^{new}$$

$$S_{supply,t}^{new} = B_{t+1} + \frac{J_{t+1} + d_{t+1}}{\frac{1+i_{t+1}}{\Pi_{t+1}}}.$$

6. Repeat steps 2-4 until both the value $|S_{demand,t} - S_{supply,t}|$ and $|S_{supply,t}^{new} - S_{supply,t}|$ are sufficiently small for all t .

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