Lending Relationships and Labor Market Dynamics

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Abstract

Standard labor search models face limitations in replicating the empirical volatility of unemployment and market tightness. We document a positive link between measures of credit-market distress and unemployment, and a negative link between measures of credit-market distress and labor force participation. We introduce monopolistic competition and persistent lending relationships in the banking system into an RBC search model with endogenous labor force participation. Amid aggregate productivity and financial shocks that replicate the empirical volatility of labor force participation and credit spreads, the model can replicate close to 90 percent of the volatility of unemployment and virtually all of the volatility in market tightness in the data. The interaction between endogenous participation in labor markets and long-lasting lending relationships plays a key role by providing a powerful amplification mechanism of financial shocks. We illustrate the policy relevance of accounting for labor force participation by analyzing the impact of countercyclical unemployment benefits and interest rate subsidies. We find that both are effective stabilization interventions.

JEL Classification: E24, E32, E44.

Keywords: unemployment, endogenous labor force participation, financial shocks, deep habits in credit markets, lending relationships.

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1 Introduction

The U.S. financial crisis of 2008-2009 made clear how credit disruptions can have significant consequences for unemployment, and for labor market outcomes more generally. Since then, a growing literature has shed light on the connections between financial and labor markets from an empirical standpoint (Amiti and Weinstein, 2011; Boeri et al., 2013; Cingano et al., 2016; Duygan-Bump et al., 2015; Greenstone et al., 2014; and Haltenhof et al., 2014; among others). Other studies have focused on the firm-level effects of financial constraints, showing that workers in firms that face negative credit shocks experience lower employment, earning losses and, if laid off, longer unemployment spells (see Bentolila et al., 2015, for Spain, Berton et al., 2016, for Italy; Hochfellner at al., 2016, for Germany, and Siemer, 2016, for the U.S.).[1] The crisis also drew attention to the cyclical response of labor force participation (see, for example, Erceg and Levin, 2014). While recent theoretical work has gone a long way in quantifying the role of financial *shocks* in explaining labor market fluctuations (Garín, 2015; Eckstein et al., 2015; Epstein, Finkelstein Shapiro, and González Gómez, 2017), the literature has generally focused on the role of labor-demand factors and has payed less attention to the role, if any, of labor force participation in affecting the cyclical behavior of unemployment.[2]

In this paper, we document that measures of credit distress are positively correlated with unemployment and negatively correlated with labor force participation. We introduce borrower-lender relationships in the form of "deep habits" in credit markets, as in Aliaga-Díaz and Olivero (2010), into a general equilibrium search model with endogenous labor force participation in the spirit of Arseneau and Chugh (2012). We use the model to shed light on how the interaction between labor force participation and credit market disruptions affects labor market and aggregate dynamics. Our results are twofold. First, calibrating the model to match the volatility of interest rate spreads and labor force participation amid aggregate productivity and financial shocks, we find that the interaction between endogenous movements in labor force participation and the long-lasting credit relationships goes a long way in quantitatively replicating the volatility of unemployment and market tightness in the data. Specifically, under our baseline calibration, our model can generate 85 percent of the volatility of unemployment and virtually all of the volatility in market tightness in the data, all while also generating factually-consistent macroeconomic dynamics. Importantly, the model's ability to match the data does not hinge on having a

[1]Berton et al. (2016) also study the within-firm personnel dynamics in response to financial shocks. They show that credit crunches mainly affect less educated or less skilled workers, which is consistent with firms responding by upgrading the average skill level of their workforce.

[2]A clear exception is Chugh (2013), who studies the role of financial *constraints* amid endogenous participation and TFP shocks. However, his work does not consider the role of financial disturbances.

high value of unemployment benefits or a low worker bargaining power. Second, we use the model to explore the impact of countercyclical credit and labor market policies on labor markets. We find that both countercyclical unemployment benefits and interest rate subsidies limit the fall in labor force participation in response to credit market disruptions, thereby reducing the contraction in employment, consumption, and ultimately output.

In our framework, firms face frictional labor markets and develop long-term credit relationships, or "deep habits", with lenders in order to finance their working capital needs, including the cost of vacancy postings. In turn, households supply deposits to lenders and are able to choose the measure of individuals that participate in the labor market. The presence of working capital constraints in a context with long-lasting lending relationships establishes an endogenous, two-way link between the state of credit markets and labor market conditions. By introducing a tradeoff between banks' present and future profits from lending over the business cycle, deep habits and long-lasting lending relationships amplify the economy's response to shocks by generating countercyclical borrowing costs.[3] In turn, relative to an economy with constant participation, the (factual) procyclical behavior of endogenous labor force participation gives rise to endogenous wage rigidities amid productivity and financial shocks. Critically, this wage rigidity amplifies the response to both productivity and financial shocks, ultimately making vacancies and the unemployment rate considerably more volatile (for a given set of shocks). Thus, to the extent that deep habits in credit markets make financial shocks more relevant for labor market and aggregate fluctuations, and that endogenous participation amplifies the response of such shocks by making wages more rigid, the interaction between endogenous participation and deep habits creates powerful amplification mechanism that can quantitatively explain the cyclical volatility of market tightness and unemployment in the data once financial shocks are taken into account. Importantly, we show that absent endogenous participation (exogenous financial disruptions), the model can only explain one-tenth (one-fifth) of the volatility of unemployment and market tightness in the data. Thus, endogenous labor force participation—that is, a labor-supply (as opposed to labor-demand) factor—represents a powerful decision margin that amplifies the response of the labor market to financial disruptions, with long-lasting lending relationships being the vehicle through which such shocks affect participation.

Our work is closest to recent work on the interaction between financial and labor market frictions. More specifically, Chugh (2013) and Petroksy-Nadeau (2014) show that introducing countercyclical credit spreads significantly increases the volatility of unemployment, vacancies and labor market tightness, thereby overcoming a key limitation of standard search models where the Shimer (2005) puzzle is present. In turn, López and Olivella (2014) show

[3]The countercyclical nature of spreads is consistent with Chugh (2013) and Petroksy-Nadeau (2014.

that in the context of both TFP and financial shocks, a model with heterogeneous workers (skilled and unskilled) can reproduce a sizeable part of the cyclicality of unemployment. Garín (2015) shows that, amid financial shocks, a one-sector RBC model with search and financial frictions can capture 75 percent of the volatility of vacancies and almost 50 percent of the volatility of unemployment in the data. Zanetti (2015) extends a standard search model to account for frictions in firms' ability to raise funds and issue dividends. A key finding is that, while financial shocks clearly affect the dynamics of wages, it is shocks to job destruction that can explain the cyclical dynamics of output and unemployment in the data. Eckstein et al. (2017) introduce default, shocks to interest rates, and vacancy costs subject to a working capital constraint into an otherwise standard search model with capital. In the presence of volatile corporate interest rates, their framework can capture roughly 80 percent of the empirical volatility of unemployment and market tightness.[4] Finally, closest to our work is Epstein, Finkelstein Shapiro, and González Gómez (2017), who study the interaction between on-the-job search, financial frictions, and financial shocks amid empirically-consistent TFP and financial shocks. Their model can quantitatively reproduce the cyclical dynamics of both labor market and aggregate variables, including the sharp deterioration in labor market conditions during the global financial crisis of 2008-2009, and stresses the role of financial shocks for explaining the volatility of unemployment. A key modeling innovation in our work relative to existing studies on financial frictions and labor markets is the combination of search-based endogenous labor force participation *and* long-lasting lending relationships in an environment with financial shocks.[5] The focus on participation represents a key difference relative to existing work on financial shocks and frictional labor markets. While our model's ability to generate high unemployment volatility is similar to Epstein, Finkelstein Shapiro, and González Gómez (2017), the channel through which this occurs is complementary: in our model, the search behavior of the non-employed (i.e., those thinking about participation at the margin) is critical, whereas in Epstein et al. (2017), the search behavior of the *currently employed* is fundamental for generating quantitatively-factual unemployment dynamics.

The paper proceeds as follows. In section 2 we provide some empirical motivation for the links between labor and financial markets that we introduce in our framework. In section 3 we lay out the model. In section 4 we present details on the calibration and all simulation results. Section 5 concludes. In the appendix we present several robustness

[4]For related work on how financial frictions affect wage-setting and unemployment see Monacelli et al. (2012).

[5]The importance of labor force participation for unemployment dynamics is consistent with recent work on unemployment dynamics in emerging economies (EMEs), where the volatility of labor force participation, coupled with foreign interest rate shocks and the distinct labor market structure in EMEs, plays an important role in quantitatively explaining the volatility of unemployment in these economies (see Finkelstein Shapiro, 2018).

checks on the assumptions of the model.

2 Empirical Motivation

Table 1 shows unconditional correlations and their significance levels for six different measures of credit market conditions and nine different measures of labor market conditions. All credit and labor measures we use reflect aggregate trends. The credit measures are presented row-wise and include: the spread between the effective loan rate on all commercial and industrial loans and the risk-free rate on U.S. Treasury bills; the average loan size; total loans; the percentage of loans that is backed by the Small Business Administration (SBA) agency; risk ratings; and the average maturity of loans. The measures of labor market conditions are presented column-wise and include: three of measures of the unemployment rate (one of which accounts for discouraged workers); the duration and the level of unemployment; the unemployment rate for college and high school graduates; and measures of both short-term and long-term unemployment. Importantly, we also show the correlation of credit market conditions with the labor force participation rate.

Several patterns are worth noting. First, as expected and consistent with existing work, a tightening of credit conditions—measured by an increase in spreads—is associated with higher unemployment levels and rates, longer unemployment duration, but lower short-term and higher long-term unemployment. A relaxation of credit frictions—measured by either an increase in the average size of loans or total loans, or an increase in the percentage of loans backed by the SBA—is associated with less unemployment as well as with a shift from long-term to short-term unemployment. Higher credit risk is also associated with worse labor market conditions. In contrast, the average maturity of loans does not seem to play any significant role in affecting labor markets other than lowering the rate of short-term unemployment and raising the rate of long-term unemployment. *Turning to the connection between credit market conditions and labor force participation, a tightening of credit conditions—measured by an increase in spreads and higher credit risk—is associated with lower participation. In contrast, a relaxation of credit frictions—measured by an increase in total loans—is associated with greater participation in the labor market. To the extent that participation also responds to changes in credit-market conditions, changes in participation can have non-negligible consequences for unemployment dynamics.*

Figure 1 uses sectoral data at the NAICS 3-digit level from the Annual Survey of Manufactures for 2002-2014 to present a complementary picture that stresses the importance of credit constraints for labor markets.[6] For each sector, we considering the following measures of labor market conditions: employment, number of hours worked, cost of contract

[6]Data on participation by sector is not available. As such, we only present evidence on measures of labor market conditions as reflected in employment and hours worked.

work (as a percentage of the total payroll), and production worker wages (as a percentage of the total payroll). Reductions in employment and/or hours, an increase in the share of contract workers, and a drop in the share of production workers indicate a worsening of labor conditions. We also calculate two sector-specific measures of credit constraints: capital expenditures and inventories, both as a percentage of the total payroll. Then, we classify each sector based on whether it belongs to the bottom 10 percent or the top 10 percent of the distribution of these credit-constraint measures. The first category captures highly-constrained sectors, while the second one captures less-constrained sectors. Finally, for each of the two credit-constraint categories we consider, we calculate the average across sectors for each of the labor market measures.

The following patterns emerge at the sectoral level. During the global financial crisis of 2008-2009, sectors in the bottom 10 percent of the distribution of the inventories-to-payroll ratio displayed a larger drop in both employment and hours, a larger increase in the share of contract employment, and a larger fall in the share of production workers relative to the less-constrained sectors. These patterns are also evident when we consider the capital expenditures-to-payroll ratio as a complementary measure of credit constraints. All told, this evidence suggests that the degree to which firms are credit-constrained is a relevant determinant of employment and other measures of labor market conditions. This is already known from existing literature on credit and labor markets.

Figure 1: Credit Frictions and Labor Markets: Sector-Level Data

	U rate	**U&D rate**	**U duration**	**U level**	**U college**	**U high school**	**U short**	**U long**	**P rate**
Spread	0.5562*	0.5602*	0.4466*	0.5323*	0.5365*	0.5785*	−0.4659*	0.5353*	−0.2979*
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0.0081)
Average loan size	−0.3287*	−0.3273*	−0.2586*	−0.3579*	−0.3654*	−0.3339*	0.3918*	−0.3194*	0.2493
	(0.0033)	(0.0034)	(0.0223)	(0.0013)	(0.001)	(0.0028)	(0.0004)	(0.0044)	(0.0277)
Total loans	−0.6112*	−0.6126*	−0.5482*	−0.6337*	−0.6646*	−0.6196*	0.71*	−0.6226*	0.5105*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SBA-backed loans (%)	−0.2828	−0.2807	−0.2588	−0.2109	−0.2610*	−0.2212	0.1852	−0.2831	-0.1240
	(0.271)	(0.282)	(0.323)	(0.421)	(0.311)	(0.393)	(0.477)	(0.271)	(0.6353)
Risk rating	0.4148*	0.4176*	0.3839*	0.4146*	0.4199*	0.4369*	−0.4787*	0.4165*	−0.3551*
	(0.0002)	(0.0001)	(0.0005)	(0.0002)	(0.0001)	(0.0001)	(0)	(0.0001)	(0.0014)
Maturity	0.1118	0.1325	0.5473*	0.1756	0.1886	0.1752	−0.4336*	0.4252*	−0.7890*
	(0.3298)	(0.2474)	(0.00)	(0.1241)	(0.0981)	(0.125)	(0.0001)	(0.0001)	(0.0001)

U rate is the unemployment rate. U&D rate is the rate of unemployment and discouraged workers. U duration is the duration of unemployment measured in weeks. U level is the number of unemployed measured in thousands of people. U college and U high school are the unemployment rates for college and high school graduates, respectively. U short (U long) is the number of people unemployed for less than 5 (more than 27) weeks expressed as a percentage of the labor force. P rate is the labor force participation rate.

Sources: Labor market data from the Current Population Survey published by the US Bureau of Labor Statistics and their Employment Situation release.Credit conditions data are from the Survey of Terms of Business Lending published by the Board of Governors of the Federal Reserve System.

Table 1: Credit Frictions and Labor Markets: Aggregate Data

3 The Model

We extend an RBC model with frictional labor markets and endogenous labor force participation in the spirit of Arseneau and Chugh (2012) to incorporate frictional credit markets. Specifically, we assume that firms are subject to a working capital constraint according to which a fraction of firms' total costs, which include capital purchases, vacancy posting costs, and the wage bill, must be financed with external resources from financial intermediaries. In order to borrow external funds, firms develop endogenously-persistent credit relationships with monopolistically competitive lenders in the banking sector. These relationships, modeled by introducing "deep habits" in credit markets as in Aliaga-Díaz and Olivero (2010), generate countercyclical credit margins, as observed in the data.

3.1 Households

There is a representative household with a measure [0,1] of members indexed by h. Following the business cycle search literature, wthere is perfect risk-pooling within the household (see Merz, 1995, and Andolfatto, 1996). At any given point in time,household members can be in one of three different states: employed by production firms ($n_{h,t}$), unemployed and actively searching for a job ($s_{h,t}$), or outside of the labor force ($1 - n_{h,t} - s_{h,t}$).

Households consume (c), accumulate capital (k) to rent out to firms, and make a choice over bank deposits (d). Specifically, households maximize expected lifetime utility $E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - h((1 - f(\theta_t))s_{h,t} + n_{h,t})\right]$ subject to a sequence of flow budget constraints, the law of motion of capital, and the perceived evolution of employment, respectively:

$$\begin{aligned} c_t + d_t + i_t + T_t &= w_t n_{h,t} + r_t k_t + b(1 - f(\theta_t))s_{h,t} + R_{d,t-1}d_{t-1} + \Pi_t, \qquad (1)\\ k_t &= (1-\delta)k_{t-1} + i_t, \qquad (2)\\ n_{h,t} &= (1-\rho^n)n_{h,t-1} + s_{h,t}f(\theta_t), \qquad (3)\end{aligned}$$

where $u'(\cdot) > 0, u''(\cdot) < 0$ and $h'(\cdot) > 0, h''(\cdot) > 0$.[7] In the budget constraint, T_t denote lump-sum taxes and total firm and bank profits are given by $\Pi_t = \int_0^1 \pi_{i,t} di + \int_0^1 \pi_{j,t} dj$, where i and j are used to index firms and banks, respectively. w_t and r_t denote the real wage and capital rental rate, respectively, b is the flow value of unemployment benefits, and $f(\theta_t)$ is the endogenous job-finding probability, which depends on market tightness $\theta_t = v_t/s_{h,t}$, where v_t denotes firm vacancies. R^d is the real gross deposit rate and δ is the exogenous capital depreciation rate. In equation (3), ρ^n is the exogenous job separation probability so that the stock of employment in period t is given by the stock in $t-1$ net of exogenous

[7] Note that, following Arseneau and Chugh (2012), we adopt the "instantaneous hiring" assumption, whereby matches in period t become productive in period t.

separation plus the number of people actively looking for jobs who actually find one with probability $f(\theta_t)$. Note that labor force participation is given by $lfp_t \equiv (1-f(\theta_t))s_{h,t}+n_{h,t}$, so that we can write $h((1-f(\theta_t))s_{h,t}+n_{h,t}) = h(lfp_t)$ as in Arseneau and Chugh (2012). In turn, the unemployment *rate* is given by $ur_t = (1-f(\theta_t))s_{h,t}/lfp_t$.

The household's first-order conditions are given by:

$$u'(c_t) = \beta E_t u'(c_{t+1}) R_{d,t}, \tag{4}$$

$$u'(c_t) = \beta E_t u'(c_{t+1}) \left[r_{t+1} + (1-\delta)\right], \tag{5}$$

$$\frac{h'(lfp_t)}{u'(c_t)} = f(\theta_t)\left[w_t + (1-\rho^n)\beta E_t\left(\frac{1-f(\theta_{t+1})}{f(\theta_{t+1})}\right)\left(\frac{h'(lfp_{t+1})}{u'(c_{t+1})} - b\right)\right] + (1-f(\theta_t))b \tag{6}$$

The first two conditions are standard: households equate the marginal cost of saving to the expected marginal benefit from holding deposits, and the marginal cost of saving to the expected marginal benefit of having an additional unit of capital. The last condition characterizes the household's optimal labor force participation decision, where households equate the marginal cost of participating in the labor market to the expected marginal benefit. The latter is given by the real wage and the future (expected) value of the employment relationship if a match with a firm occurs with probability $f(\theta_t)$, and the flow contemporaneous value of unemployment benefits b, which a household member receives with probability $(1-f(\theta_t))$. This last condition is identical to the one in Arseneau and Chugh (2012). For future reference, we define the household's stochastic discount factor as $\Xi_{t+1|t} \equiv \beta u'(c_{t+1})/u'(c_t)$.

3.2 Production Firms

The production sector is comprised of a continuum of firms on the unit interval indexed by i. Each firm hires labor n_{it} at a cost of w_{it} per worker, rents capital k_{it} from households at a cost of r_t per unit of capital, and posts vacancies ν_{it}. The total cost of posting vacancies is given by $\varrho(\nu_i)$, where $\varrho'(\cdot) > 0, \varrho''(\cdot) \geq 0$. In the presence of labor search frictions, firm i's perceived law of motion for its stock of employment is:

$$n_{it} = (1-\rho^n)n_{it-1} + \nu_{it} q\left(\theta_t\right). \tag{7}$$

where $q(\theta_t)$ denotes the job-filling probability.

In turn, the firm's total operating costs are given by $M_{it} \equiv [w_t n_{it} + r_t k_{it} + \varrho(\nu_{it})]$. We assume that a fraction $0 \leq \phi \leq 1$ of these costs is must be paid in advance so that firms face a working capital constraint on all relevant costs.

As in Aliaga-Díaz and Olivero (2010), production firms borrow from a set of monopolistically competitive banks (indexed by j) that offer differentiated loan services. To do so, borrowing firms develop deep habits with their lenders. The amount of liquidity services obtained from the banking sector is then given by:

$$x_{it} = \left[\int_0^1 \left(l_{ijt} - \theta_{b,t} s_{jt-1}\right)^{\frac{\xi_t - 1}{\xi_t}} dj\right]^{\frac{\xi_t}{\xi_t - 1}}, \tag{8}$$

$$s_{jt-1} = \rho^s s_{jt-2} + (1-\rho^s) l_{jt-1}, \tag{9}$$

where $l_{i,j,t}$ is the i-th firm demand for credit from the j-th bank in period t, and ξ is the elasticity of substitution across loan varieties, which is subject to shocks that capture exogenous financial disturbances. The case with $\theta_b > 0$ captures the notion of "deep habits" in banking. The loan composite is expressed in units of an aggregate consumption good. The term $\theta_{b,t} s_{j,t-1}$ in $x_{i,t}$ is intended to capture the *borrower "hold-up"* effect, with θ_b measuring the extent of the hold-up. The term $s_{j,t-1}$ in (8) is defined as $s_{jt-1} \equiv \int_0^1 s_{i,j,t-1} di$, which corresponds to the beginning of period t cross-sectional (across production firms) average stock of accumulated past loans obtained from the j-th bank. The stock of habits $s_{j,t-1}$ follows the law of motion in equation (9). More specifically, it is a linear function of its value in the previous period and the average level of borrowing from the j-th bank in $t-1$, $l_{j,t-1} \equiv \int_0^1 l_{i,j,t-1} di$.

First, we find the i-th firm optimal relative demand for loans issued by the m-th bank. This is obtained by minimizing total borrowing costs, $\int_0^1 R^l_{j,t} l_{i,j,t} dj$, subject to (8). The solution gives an expression for l_{ijt}–the i-th firm optimal demand for loans issued by the $j-$th bank–as a function of the relative loan rate charged by the j-th bank and the stock of borrowing habits related to the same loan variety:

$$l_{i,j,t} = \left(\frac{R^l_{j,t}}{R^l_t}\right)^{-\xi_t} x_{it} + \theta_b s_{j,t-1}, \tag{10}$$

where $R^l_t \equiv \left[\int_0^1 \left(R_{l,jt}\right)^{1-\xi_t} dj\right]^{\frac{1}{1-\xi_t}}$ defines the aggregate loan rate index. As equation (10) states, l_{ijt} is higher the cheaper it is to borrow from the j-th bank (i.e. lower $\frac{R_{l,jt}}{R_{l,t}}$) and/or the stronger is the lender-borrower relationship established with that bank (i.e. the larger θ_b and/or s_{jt-1} are). Second, each firm i chooses the demand for labor and capital as well as vacancy postings to maximize the expected present discounted value of lifetime profits with period t profits given by $\pi_{it} = \left[y_{i,t} + x_{i,t} - (1-\phi) M_{i,t} - \int_0^1 R^l_{j,t-1} l_{i,j,t-1} dj\right]$. Imposing the conditions $x_{i,t} = \phi M_{i,t}$ and $\int_0^1 R^l_{j,t} l_{i,j,t} dj = R^l_t x_{i,t} + \Gamma_t$, firm i's problem is to

$$\max_{n_{i,t},\nu_{i,t},k_{i,t},x_{i,t}} E_0 \sum_{t=0}^{\infty} \Xi_{t|0} \pi_{it} \tag{11}$$

subject to

$$\begin{aligned}
\pi_{it} &= \left[y_{it} + x_{it} - (1-\phi)\, K_{it} - R_{l,t-1} x_{it-1} + \Gamma_t\right], && (12)\\
y_{it} &= A_t f(n_{it}, k_{it}) && (13)\\
n_{it} &= (1-\rho^n) n_{it-1} + \nu_{it} q(\theta_t), && (14)\\
M_{it} &\equiv \left[w_t n_{it} + r_t k_{it} + \varrho(\nu_{it})\right], && (15)\\
& && (16)
\end{aligned}$$

and the definition of profits, where $\Xi_{t|0}$ is the stochastic discount factor, A denotes total factor productivity and follows an AR(1) process, $\Gamma_t \equiv \theta \int_0^1 R_{l,jt-1} l_{jt-1} dj$, and equation (14) represents the perceived law of motion for labor.

Firm i's job creation condition is given by

$$\frac{\varrho'(\nu_{it})\left[(1-\phi) + \phi E_t \Xi_{t+1|t} R_{l,t}\right]}{q(\theta_t)} =$$

$$\frac{\partial y_{it}}{\partial n_{it}} - w_t\left[(1-\phi) + \phi E_t \Xi_{t+1|t} R_{l,t}\right] + (1-\rho^n) E_t \Xi_{t+1|t}\left[\frac{\varrho'(\nu_{it+1})\left[(1-\phi) + \phi \Xi_{t+2|t+1} R_{l,t+1}\right]}{q(\theta_{t+1})}\right], \quad (17)$$

which equates the expected marginal cost of posting a vacancy to the expected marginal benefit. The latter is comprised of the marginal product of labor net of the real wage, adjusted for the fact that firms must pay a fraction of their wage bill in advance, and the continuation value of the employment relationship.

The demand for capital by firm i is given by

$$\frac{\partial y_{it}}{\partial k_{it}} = \frac{\partial M_{it}}{\partial k_{it}}\left[(1-\phi) + \phi E_t \beta \Xi_{t+1|t} R_t^l\right]. \quad (18)$$

Equation (18) is a standard condition that equates the marginal benefit to the marginal cost of capital, where $r_t = \frac{\partial M_{it}}{\partial k_{it}}$. Of note, the marginal cost of purchasing a unit of capital takes into account the fact that a fraction of the cost of capital needs to be financed with external funds. It also takes into account the fact that increasing the capital stock raises operating costs and working capital needs and therefore tightens the collateral constraint.

3.3 Matching and Wage Determination

Following the search and matching literature, there is a constant-returns-to-scale matching function $m(s_{h,t}, \nu_t)$. Then, the matching probabilities are: $f(\theta_t) \equiv m(s_{h,t}, \nu_t)/s_{h,t}$ and $q(\theta_t) \equiv m(s_{h,t}, \nu_t)/v_t$. The law of motion for aggregate employment can then be written as:

$$n_t = (1-\rho) n_{t-1} + m(s_{h,t}, \nu_t). \quad (19)$$

We assume bilateral Nash bargaining between households and firms. Let $\mathbf{S}_t$ be the joint surplus of the firm-worker match, which is split between each side of the market according to the worker's and the firm's bargaining powers, $0 < \eta_n < 1$ and $(1-\eta_n)$, respectively. Specifically,

$$\eta_n \mathbf{S}_t = \mathbf{M}_t, \quad (20)$$

$$(1-\eta_n)\mathbf{S}_t = \mathbf{J}_t, \quad (21)$$

where $\mathbf{J}_t \equiv \frac{\varrho(\nu_{it})\left[(1-\phi)+\phi E_t \Xi_{t+1|t} R_t^l\right]}{q(\theta_t)}$, and $\mathbf{M}_t \equiv \frac{h'(lfp_t)-u'(c_t)b}{u'(c_t)f(\theta_t)}$ denote the marginal value of employment for the households and firms, respectively (see Arseneau and Chugh, 2012).

Then, the Nash wage is implicitly given by the surplus sharing rule

$$\mathbf{M}_t = \frac{\eta_n}{(1-\eta_n)\left[(1-\phi)+\phi E_t \Xi_{t+1|t} R_t^l\right]} \mathbf{J}_t. \quad (22)$$

This expression shows that credit market conditions effectively affect how the surplus from employment relationships is shared, and will therefore affect (1) firms' incentives to search for workers via vacancy postings, and (2) households' incentives to search for employment.

3.4 Banks

There is a continuum of banks indexed by $j \in [0,1]$. Each variety of loans/financial services is produced by a bank operating in a monopolistically-competitive loan market. Banks are competitive in the market for deposits. Banks are owned by households so that their discount factor is given by the households' intertemporal marginal rate of substitution.

In each period t, bank j chooses its demand for deposits $(d_{j,t})$ and the interest rate charged on loans (R_t^l) to maximize the expected present discounted value of its lifetime profits. Bank j's optimization problem is given by

$$\max_{d_{j,t}, R_{j,t}^l} \quad E_0 \quad \sum_{t=0}^{\infty} \Xi_{t|0} \Pi_{j,t}, \quad (23)$$

subject to

$$\Pi_{j,t} = d_{j,t} - l_{j,t} + R_{j,t-1}^l l_{j,t-1} - R_{t-1}^d d_{j,t-1} - \kappa_t, \quad (24)$$

$$l_{j,t} = d_{j,t}, \quad (25)$$

$$l_{j,t} \equiv \int_0^1 l_{i,j,t} di = \int_0^1 \left[\left(\frac{R_{i,t}^l}{R_t^l} \right)^{-\eta} x_{i,t} + \theta_{b,t} s_{j,t-1} \right] di. \quad (26)$$

Equation (24) is the bank's cash flow in period t, where R^d is the common risk-free interest rate on deposits paid by all banks. κ denotes the fixed costs of production, which limits entry into the monopolistically competitive banking sector. The presence of κ ensures that profits are relatively small on average, in spite of equilibrium price-cost margins being significantly positive. Equation (25) is bank j's balance sheet condition, and equation (26) shows the aggregate demand from firms that bank j internalizes.

The first order conditions with respect to $l_{j,t}$ and $R^l_{j,t}$ are

$$\Omega_{j,t} = E_t\Xi_{t+1|t}\left[(R^l_{j,t} - R^d_t) + \theta_{b,t+1}\Omega_{j,t+1}(1-\rho^s)\right], \tag{27}$$

$$E_t\Xi_{t+1|t}l_{j,t} = -\Omega_{j,t}\frac{\partial l_{j,t}}{\partial R^l_{j,t}}, \tag{28}$$

respectively, where Ω_{jt} is bank j's shadow value of lending an extra unit in period t.

Equation (27) states that the value of lending an extra unit in period t is comprised of two terms: the short-run returns of that operation $((R^l_{j,t} - R^d_t)E_t\Xi_{t+1|t})$, and the future expected profits associated with the fact that a share of this lending will be "held-up" in period $t+1$ as a result of deep habits in credit markets. Equation (28) states that the marginal revenue from an increase in the interest rate (given by the discounted value of the loans $l_{j,t}E_t\Xi_{t+1|t}$) must equal the marginal cost of that increase (given by the resulting reduction in the quantity demanded of loans $\frac{\partial l_{j,t}}{\partial R^l_{j,t}}$ evaluated at the shadow price $\Omega_{j,t}$).

3.5 Government

The government's budget constraint states that government spending on unemployment benefits should balance out with tax revenues from lump-sum taxes:

$$b(1-f(\theta_t))s_{h,t} = T_t. \tag{29}$$

Combining the government budget constraint, the household budget constraint, production firms' profits, and banks' profits yields the economy's resource constraint.

4 Quantitative Analysis

4.1 Functional Forms and Calibration

Functional Forms We assume standard functional forms commonly used in the business cycle and labor search literatures: $u(c_t) = \ln c_t$ and $h(lfp_t) = [\psi/(1+1/\iota)]\, lfp_t^{1+\frac{1}{\iota}}$, where $\iota > 0$. The production and matching functions are Cobb-Douglas: $f(n_t, k_t) = n_t^{1-\alpha}k_t^{\alpha}$ and $m(s_t, v_t) = Ms^{\mu}_{h,t}v_t^{1-\mu}$, where $0 < \alpha, \mu < 1$ and a scaling parameter that captures matching efficiency $M > 0$. The total cost of posting vacancies is $\varrho(\nu_t) = \gamma v_t$, where $\gamma > 0$. Finally, we assume that aggregate productivity A_t follows an independent AR(1) process in logs with autocorrelation coefficient $\rho_A < 1$ and shocks $\varepsilon^A_t \sim N(0, \sigma_A)$. In turn, the elasticity of substitution across loans follows an independent AR(1) process in logs with autocorrelation coefficient $\rho_\xi < 1$ and shocks $\varepsilon_t^\xi \sim N(0, \sigma_\xi)$.

Parameters from Literature: A period is a quarter. We follow the DSGE and labor search literatures and assume that the capital share $\alpha = 0.34$, the subjective discount factor $\beta = 0.99$, and the depreciation rate $\delta = 0.025$. We set the matching elasticity and Nash bargaining power to $\mu = 0.4$ and $\eta_n = 0.5$, respectively (Petrongolo and Pissarides, 2001; Shimer, 2005), and the job separation probability $\rho_n = 0.10$ (Arseneau and Chugh, 2012). Our baseline calibration assumes that the elasticity of substitution of bank loans $\eta = 11$, the working capital parameter $\phi = 0.5$, the persistence of loans $\rho_s = 0.5$, and the steady-state banking deep-habits parameter $\theta_b = 0.5$. We explore how our results change under alternative parameter values for the banking sector in the Appendix. Finally, we normalize $A = 1$ and set $\rho_A = 0.95$, $\sigma_A = 0.007$, and $\rho_\xi = 0.50$.

Calibrated Parameters: We calibrate the remaining parameters b, M, γ, ψ, ι, and σ_ξ to match: a replacement rate of 50 percent, job-finding and job-filling probabilities equal to 0.60 and 0.70, respectively, a labor force participation rate of 0.657, a relative volatility of labor force participation of 0.171, and a relative cyclical volatility of interest rate spreads of 49.1. These targets are consistent average replacement rates in the U.S., the average U.S. participation rate as well as its cyclical volatility over our sample period (1987Q1-2017Q1), standard values for the matching probabilities based on CPS data, and the volatility of interest rate spreads over our sample period, based on the definition of spreads used in Section 2. This yields a flow value of unemployment benefits $b = 0.9035$, a scaling parameter in the matching function $M(s_t, \nu_t)$ $M = 0.6581$, the marginal cost of posting vacancies $\gamma = 1.0400$, the preference for leisure parameter $\psi = 159350$, the parameter governing the elasticity of participation $\iota = 0.0357$, and the standard deviation of financial shocks $\sigma_\xi = 0.3662$. All relevant parameter values are summarized in Table 2.

4.2 Business Cycle Statistics

We use data from 1987Q1 to 2017Q1 for real GDP, consumption, investment, the unemployment and labor force participation rates, market tightness, and interest rate spreads to illustrate how the interaction between financial shocks, deep habits, and labor force participation is important for generating quantitatively-factual cyclical labor market and aggregate dynamics.

Table 3 shows that the benchmark model can quantitatively replicate a number of second moments in the data well. In particular, under a plausible degree of deep habits in banking, the model generates a highly volatile unemployment rate and labor market tightness, as well as countercyclical unemployment and interest rate spreads amid endogenous labor force participation that are very close to their empirical counterparts. In addition, the model generates procyclical consumption, investment, market tightness, and labor force participation, as in the data.

Table 3 also shows recalibrated versions of the benchmark model where we (1) shut down financial shocks; (2) shut down deep habits in banking; (3) assume that labor force participation (LFP) is constant and therefore exogenous (at its baseline steady-state value); and (4) a version of (3) with no deep habits in banking.[8] Comparison of the benchmark model to these model variants highlights the importance of endogenous labor force participation *alongside* deep habits in banking *amid* financial shocks for generating more empirically-factual cyclical labor market and aggregate dynamics. Indeed, abstracting from financial shocks implies that, while unemployment becomes more countercyclical and closer to the data, interest rate spreads, unemployment, and market tightness are considerably less volatile relative to both the data and to the benchmark model. Abstracting from deep habits in banking reduces the countercyclicality of interest rate spreads and the volatility of both unemployment and market tightness, though the latter two continue to remain highly volatile relative to output. Importantly, though, abstracting from endogenous LFP implies substantially lower unemployment and market tightness volatility, as well as virtually acyclical interest rate spreads.

All told, we conclude that a combination of financial shocks, deep habits in banking, and endogenous LFP generate empirically plausible aggregate dynamics for variables in both the labor and credit markets. More broadly, the interaction of financial shocks with endogenous

[8] For all these variants of the benchmark model, we recalibrate each model to match the same targets across models whenever it is appropriate (in the case of models with constant labor force participation, $\sigma_{lfp_t}/\sigma_{y_t}$ is no longer a target; a similar comment applies to the model without financial shocks, where $\sigma_{spread_t}/\sigma_{y_t}$ is no longer a target). Table A1 in the Appendix shows that our main conclusions remain unchanged if we simply shut down each of the shocks or mechanisms *without* recalibrating each of the model variants.

Preference Parameters			
Discount factor β	0.99		
Preference for leisure ψ	159350	Wage elasticity of labor supply ι	0.0357
Production Parameters			
TFP in steady state $\bar{A}$	1		
Persistence of TFP shocks ρ_A	0.95	Volatility of TFP shocks σ_A	0.007
Capital share α	0.34	Depreciation rate δ	0.025
Labor Market Parameters			
Unemployment benefits b	0.9035	Job separation probability ρ_n	0.1
Matching elasticity μ	0.4	Bargaining power η_n	0.5
Scaling parameter in $m(s_t, \nu_t)$ M	0.6581	Marginal cost of posting vacancies γ	1.0400
Credit Market Parameters			
Elasticity of substitution of bank loans η	11	Working capital share ϕ	0.5
Persistence of lending relationships ρ_s	0.5	Deep-habits parameter θ_b	0.5
Volatility of financial shocks σ_ξ	0.3662		

Table 2: Calibration

Targeted Moments	Data	Benchmark	Benchmark No Financial Shocks	Benchmark $\theta_b = 0$	Benchmark Constant LFP	Benchmark Constant LFP $\theta_b = 0$
$\sigma_{lfp_t}/\sigma_{y_t}$	0.171	0.171	0.171	0.171	–	–
$\sigma_{spread_t}/\sigma_{y_t}$	49.10	49.10	1.182*	49.10	49.10	49.10
Non-Targeted Moments						
$\sigma_{c_t}/\sigma_{y_t}$	0.844	0.322	0.341	0.343	0.380	0.380
$\sigma_{inv_t}/\sigma_{y_t}$	5.184	2.923	2.924	2.921	3.008	3.006
$\sigma_{ur_t}/\sigma_{y_t}$	9.988	8.616	2.136	5.650	1.143	1.167
$\sigma_{\theta_t}/\sigma_{y_t}$	8.755	10.00	1.754	6.572	0.905	0.913
$corr(c_t, y_t)$	0.898	0.806	0.916	0.866	0.928	0.928
$corr(inv_t, y_t)$	0.899	0.791	0.992	0.894	0.990	0.990
$corr(ur_t, y_t)$	-0.856	-0.658	-0.855	-0.641	-0.866	-0.874
$corr(lfp_t, y_t)$	0.332	0.530	0.932	0.455	–	–
$corr(\theta_t, y_t)$	0.831	0.585	0.991	0.548	0.925	0.943
$corr(spread_t, y_t)$	-0.528	-0.450	-0.547	-0.310	-0.027	-0.011

Notes: Empirical moments based on HP-filtered data with smoothing parameter 1600 from 1987Q1-2017Q1. * denotes a non-targeted moment.

Table 3: Business Cycle Statistics - Data vs. Benchmark Model and Model Variants

labor force participation is critical for generating factual movements in unemployment and market tightness that are very close to the data.

4.3 Impulse Response Functions

To understand how endogenous labor force participation amplifies financial shocks and how deep habits in credit markets act as a transmission vehicle for these shocks into labor markets, we analyze the response of the model to two shocks. First, we consider a financial shock reflected in movements in the elasticity of substitution between loans ξ. Second, we consider a standard aggregate productivity shock. The magnitude of each shock is 1 standard deviation.

In turn, we compare the responses in the benchmark model to those from three simpler alternatives to the benchmark model. First, we consider a version of the benchmark model that abstracts from deep habits in credit markets (that is, we set $\theta_b = 0$). Second, we consider a version of the benchmark model with constant labor force participation. Third, we consider a version of the benchmark model without long-lasting borrower-lender relationships. This allows us to trace out the individual contribution of each of the elements of the model—deep habits, endogenous participation, and long-lasting lending relationships—to the volatility of unemployment.

4.3.1 The Role of Deep Habits in Banking θ_b

Figures 2 and 3 compare the response to financial shocks and productivity shocks, respectively, in the benchmark model and in a model with constant margin in credit markets (that is, $\theta_b = 0$).

Figure 2 shows that a temporary and exogenous reduction in the elasticity of substitution between loans raises margins in credit markets and makes loans more expensive for employers. The *initial* increase in the cost of credit is somewhat larger in the presence of deep habits in credit markets. The intuition is simple: amid long-lasting relationships between borrowers and lenders and a contractionary financial shock, lenders face a tradeoff between: raising rates in response to the shock; seeing their profits increase, but with a reduced customer base that will be *locked-in* in $t+1$; and lowering rates at time t, thereby seeing lower contemporaneous profits but greater potential for profits in $t+1$ (since capturing a larger clientele is less likely if the recession lasts more than a few periods).

All things considered, the increase in the cost of loans is larger relative to a model with $\theta_b = 0$ where habits are not present. Firms respond by reducing vacancy postings more sharply, and tightness in labor markets falls by more than in a model without frictions in lending relationships. This leads to a more pronounced drop in real wages. Critically, households respond to the sharper drop in wages by reducing their participation. While the drop in labor force participation relative to a model without habits is not very large quantitatively, it is large enough to generate non-negligible differences in the response of the unemployment rate. As a result, we observe a larger contraction in real wages *and* employment. Given the larger deterioration in labor markets, the marginal product of capital falls by more and the drop in investment is also more pronounced. All told, the economy exhibits larger reductions in consumption and output.

The behavior of the economy is quite different in response to a temporary reduction in aggregate productivity. In this case, the response of aggregate variables such as consumption, investment, and output are quantitatively identical regardless of the persistence of lending relationships in credit markets. However, interesting compositional effects are evident from Figure 3. Notice that, as expected, with deep habits, credit spreads rise (they are constant when $\theta_b = 0$). At the same time, the response of labor force participation is more subdued under deep habits. Interestingly, this occurs despite the initially larger contraction in wages. Intuitively, this takes place because the rise in bank profits due to the temporary expansion in lending spreads offsets the decline in wages that would otherwise push individuals to reduce search. In turn, the smaller reduction in labor force participation is more than offset by the larger drop in vacancies such that the rise in unemployment is somewhat larger in the benchmark model. This further highlights how the interaction of labor force participation and financial shocks differs relative to the interaction with productivity shocks. Moreover, note that under our baseline calibration, the effects of the productivity shock on credit markets fully offset the effects on the labor market, such that the dynamics of macro aggregates are virtually the same across models.

We conclude that deep habits in credit markets amplify the response of vacancies, labor force participation, and unemployment to financial shocks, thereby leading to sharper movements in output, consumption, and investment amid these shocks. The relevance of deep habits for the amplification of productivity shocks is important insofar as it generates more countercyclical movements in lending spreads. ***Thus, deep habits are important insofar as they make financial shocks and countercyclical spreads more relevant for aggregate fluctuations vis-á-vis a model without deep habits.***

4.3.2 The Role of Endogenous Labor Force Participation

Figures 4.3.2 and 4.3.2 compare the responses to the same type of shocks in the benchmark model to those of a model with *constant* labor force participation.[9] These figures illustrate the amplification role played by labor force participation, *especially in response to financial shocks.* Specifically, as shown in Table 2, it is the response of labor force participation *to*

[9]Specifically, we fix the labor force participation to the steady-state value in the benchmark model. This is without loss of generality.

financial shocks that contributes to generating considerably higher labor market volatility relative to standard search models with constant participation. This is apparent in Figure 4.3.2, where the responses of the model with constant participation are considerably more subdued compared to the benchmark model, *even if the rise in lending spreads is somewhat similar*. This suggests that the interaction between financial shocks and endogenous participation amid deep habits in banking plays a key role for better matching the data.

Intuitively, a temporary adverse financial shock leads to a rise in lending-deposit spreads, which raises the cost of labor, capital, and vacancies. All else equal, the initial contraction in vacancies puts downward pressure on wages. This takes place regardless of whether we have endogenous participation or not. Importantly, though, amid endogenous participation, the drop in wages pushes households to reduce the measure of searchers, which leads to a contraction in labor force participation. *Critically, as shown in Figures 4.3.2 and 4.3.2, the response of participation effectively makes wages more rigid.* Indeed, as participation drops, wages fall by less, which in turn contributes to an even larger *equilibrium* reduction in vacancies (given that vacancies are partially financed with bank credit, the reduction in wages and vacancies leads to a larger reduction in bank credit). In turn, the combination of a larger drop in vacancies and in labor force participation puts upward pressure on unemployment, thereby leading to a much sharper increase in the *equilibrium* unemployment rate relative to an environment where labor force participation is constant.

We conclude that ***endogenous labor force participation introduces an endogenous wage rigidity****, both in response to productivity and financial shocks, which leads to sharper equilibrium fluctuations in vacancies and unemployment relative to an economy where labor force participation is constant. Thus,* ***endogenous participation represents a powerful amplification mechanism of shocks****.*

4.3.3 The Role of Long-Lasting Lending Relationships ρ^s

Figures 6 and 7 compare the responses of the benchmark model to those of a version of the benchmark model with more persistent lending relationships. For illustrative purposes, we set raise the length of lending relationships ρ^s from 0.50 in the baseline calibration to 0.90. This allows us to characterize the extent to which long-lasting relationships matter for the amplification and propagation of shocks.

As should be expected, extending the length of lending relationships leads to a more persistent response to financial shocks for not only all macro aggregates, but also for all labor market variables relative to the benchmark model. Intuitively, this is due to the fact that under a higher ρ^s, banks suffer proportionately less from an adverse financial shock that reduces the substitution between loans since relationships are more long-lived and they are able to keep their customers *locked-in* for a longer time. This implies that bank credit falls proportionately more relative to a model with a lower ρ^s. The sharper reduction in bank credit leads to a larger fall in investment and vacancy postings, which is ultimately reflected in larger contractions in output, consumption, labor force participation, wages, and a larger increase in unemployment.

We conclude that ***long-lasting lending relationships increase the responsiveness of labor market variables by generating sharper movements in credit markets*** *(in both lending spreads and bank credit). Similar to the case of deep habits, long-lasting lending relationships are important insofar as they increase the sensitivity of the economy to financial shocks.*

4.3.4 Summary of Results

The results in Figures 2 through 7 show that: (1) both deep habits *and* long-lasting lending relationships increase the relevance of financial shocks in generating sharper aggregate fluctuations; and (2) endogenous labor force participation leads to endogenous wage rigidities, which in turn magnify the response of vacancies and unemployment *to both financial and aggregate productivity shocks*. A natural implication, then, is that the combination of (1) and (2) introduces a powerful amplification mechanism of *financial shocks*, with endogenous participation playing a fundamental role.

5 Policy Interventions in Labor and Credit Markets

The amplification of shocks that arises amid endogenous labor force participation immediately raise questions about the effectiveness of particular cyclical interventions aimed at stabilizing labor market fluctuations in response financial disruptions. Of particular relevance are unemployment insurance (UI) benefits, which may affect individuals' participation decisions.

First, we consider the impact of countercyclical unemployment insurance (UI) benefits, that is, benefits that rise during recessions as in Challe et al. (2011). Specifically, we assume that contemporaneous UI benefits are time-varying and given by $b_t = \bar{b}\exp\left[\eta_b(y_{ss} - y_t)\right]$ where $\bar{b}$ is the steady-state value of UI benefits, y_{ss} is steady-state output, and the parameter $\eta_b > 0$ determines the cyclical response of the policy. For illustrative purposes, we set $\eta_b = 0.5$.[10]

The response of aggregate, labor, and credit market variables in response to a financial shock in this model are presented in Figure 5. All variables display an attenuated response to financial shocks under the policy.[11]

[10] For an alternative way to model countercyclical UI benefits, see Mitman and Rabinovich (2014, 2015).

[11] We delegate results for aggregate productivity shocks to the Appendix. See Figure A3.

The second type of policy intervention is a macroprudential intervention that stabilizes credit markets. We follow Hoff and Stiglitz (1998) and Jeanne and Korinek (2013) and consider countercyclical credit subsidies that limit the rise in interest rate spreads during downturns. Specifically, we assume that the lending rate R_t^l is now $\tau_{R,t}R_t^l$ where $\tau_{R,t} = \exp\left[\eta_R(y_{ss} - y_t)\right]$ and parameter $\eta_R < 0$ determines the cyclical response of the policy. For illustrative purposes, we set $\eta_R = -0.5$.

Figure 5 compares the benchmark model without policy to the same economy under the policy. Similar to the case of countercyclical UI benefits, cyclical intervention in credit markets generate smoother responses to financial shocks.[12]

Interestingly, both policies have qualitatively different effects depending on the type of shock. While both policies have the intended effects of attenuating the negative responses of the economy in the aftermath of financial shocks, these policies are not stabilizing when recessions are caused by exogenous changes in aggregate productivity.

6 Conclusions

In this paper, we document that measures of credit distress are positively correlated with unemployment and negatively correlated with labor force participation. We introduce borrower-lender relationships in the form of "deep habits" in credit markets, as in Aliaga-Díaz and Olivero (2010), into a general equilibrium search model with endogenous labor force participation in the spirit of Arseneau and Chugh (2012). We use the model to shed light on how the interaction between labor force participation and credit market disruptions affects labor market and aggregate dynamics. Our results are twofold. First, calibrating the model to match the volatility of interest rate spreads and labor force participation amid aggregate productivity and financial shocks, we find that the interaction between endogenous movements in labor force participation and the long-lasting credit relationships goes a long way in quantitatively replicating the volatility of unemployment and market tightness in the data. Specifically, under our baseline calibration, our model can generate 85 percent of the volatility of unemployment and virtually all of the volatility in market tightness in the data, all while also generating factually-consistent macroeconomic dynamics. Importantly, the model's ability to match the data does not hinge on having a high value of unemployment benefits or a low worker bargaining power. Second, we use the model to explore the impact of countercyclical credit and labor market policies on labor markets. We find that both countercyclical unemployment benefits and interest rate subsidies limit the fall in labor force participation in response to credit market disruptions, thereby reducing the contraction in employment, consumption, and ultimately output. Our

[12] WWe delegate results for aggregate productivity shocks to the Appendix. See Figure A4.

work stresses the relevance of supply-side labor market factors amid financial disruptions to better understand the cyclical behavior of labor markets.

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Table A1: Business Cycle Statistics - Data vs. Benchmark Model and Model Variants (No Recalibration)

Targeted Moments	Data	Benchmark	Benchmark No Financial Shocks	Benchmark $\theta_b = 0$	Benchmark Constant lfp	Benchmark $\theta_b = 0$ Constant lfp
$\sigma_{lfp_t}/\sigma_{y_t}$	0.171	0.171	0.022*	0.080*	–	–
$\sigma_{spread_t}/\sigma_{y_t}$	49.10	49.10	1.140*	34.75*	49.10*	29.91*
Non-Targeted Moments						
$\sigma_{c_t}/\sigma_{y_t}$	0.844	0.322	0.352	0.354	0.380	0.380
$\sigma_{inv_t}/\sigma_{y_t}$	5.184	2.923	2.923	2.920	3.008	3.006
$\sigma_{ur_t}/\sigma_{y_t}$	9.988	8.616	2.396	4.470	1.143	1.160
$\sigma_{\theta_t}/\sigma_{y_t}$	8.755	10.00	1.980	4.855	0.905	0.904
$corr(c_t, y_t)$	0.898	0.806	0.925	0.897	0.928	0.928
$corr(inv_t, y_t)$	0.899	0.791	0.993	0.948	0.990	0.990
$corr(ur_t, y_t)$	−0.856	−0.658	−0.978	−0.659	−0.866	−0.878
$corr(lfp_t, y_t)$	0.332	0.530	0.943	0.424	–	–
$corr(\theta_t, y_t)$	0.831	0.585	0.993	0.554	0.925	0.648
$corr(spread_t, y_t)$	−0.528	−0.450	−0.560	−0.205	−0.027	−0.008

Notes: Empirical moments based on HP-filtered data with smoothing parameter 1600 from 1987Q1-2017Q1. * denotes a non-targeted moment.

A Business Cycle Moments: Additional Results

Table A1 shows a version of Table 3 on the main text where we shut down each of the shocks or mechanisms in the benchmark model without recalibrating any of the model variants. The results below confirm that the conclusions from Table 1 remain unchanged even if we do not recalibrate simpler versions of the benchmark model.

B Impulse Response Functions: Additional Results

Persistent Financial Shocks Figures A1 and A2 show the same results as Figures 2 and 3 in the main text when we calibrate the model under persistent shocks to ξ (for illustrative purposes, we assume that ξ follows an AR(1) process with persistence parameter $\rho_\xi = 0.50$). The figures below confirm that our main results remain unchanged.

Policy Interventions in Labor and Credit Markets Figures A3 and A4 show the results for policy interventions in labor and financial markets, respectively for the case of supply-side shocks to A

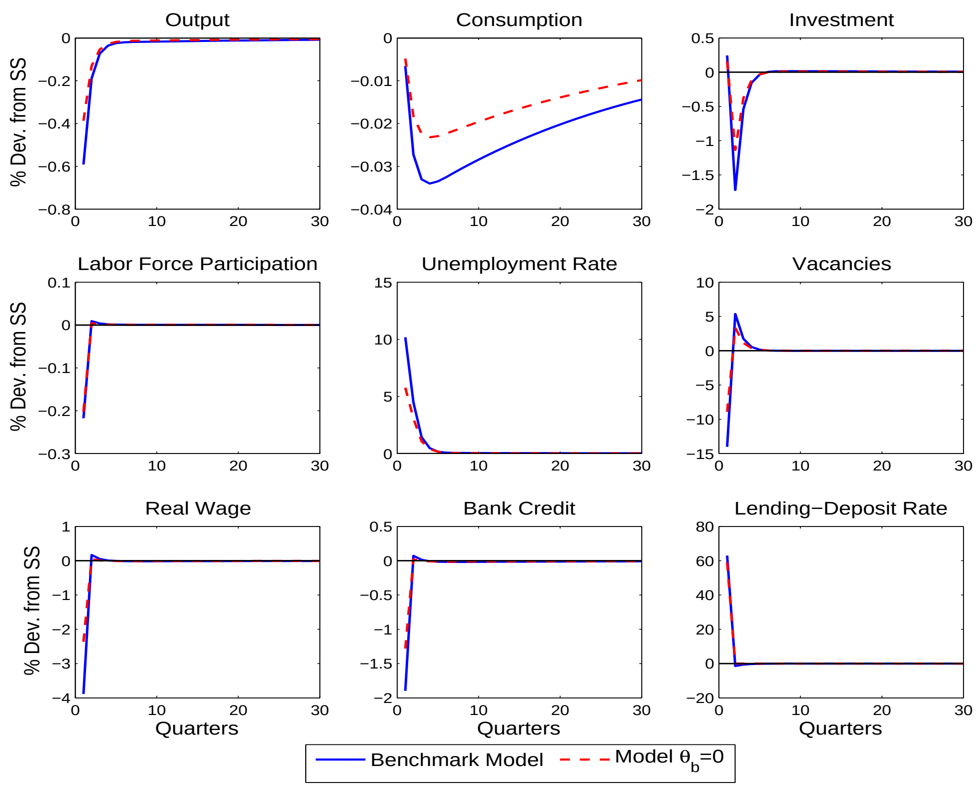

Figure 2: Response to a One Standard Deviation Reduction in Elasticity of Substitution of Loans ξ–The Role of Deep Habits in Banking

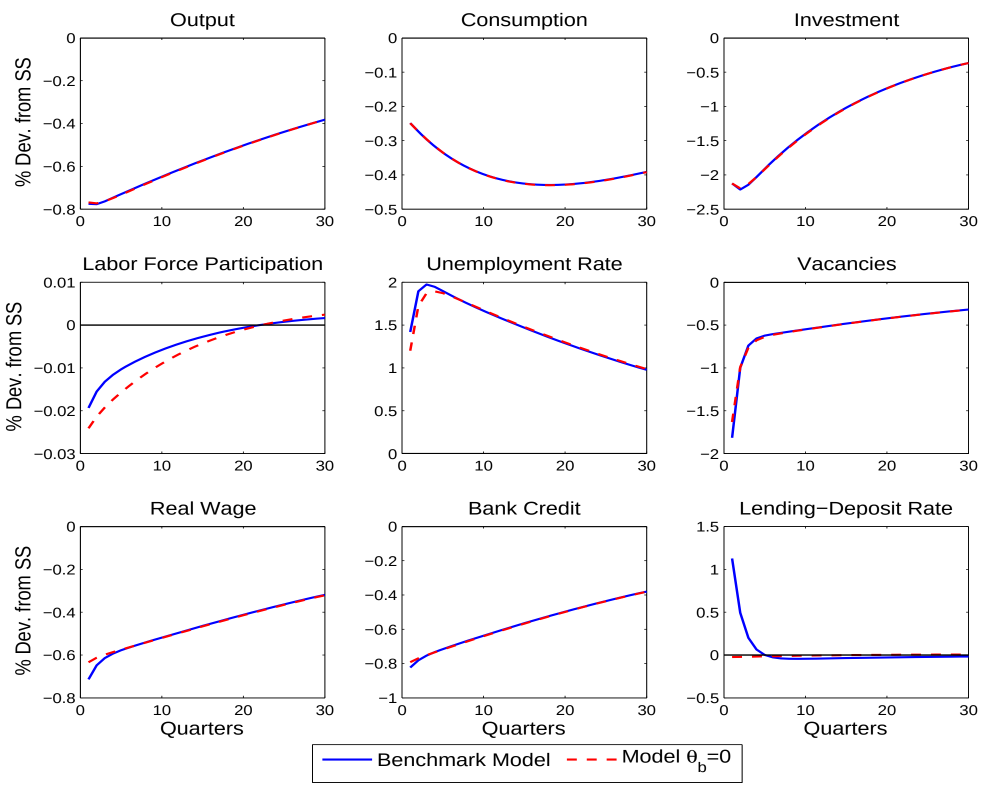

Figure 3: Response to a One Standard Deviation Reduction in Aggregate Productivity A–The Role of Deep Habits in Banking

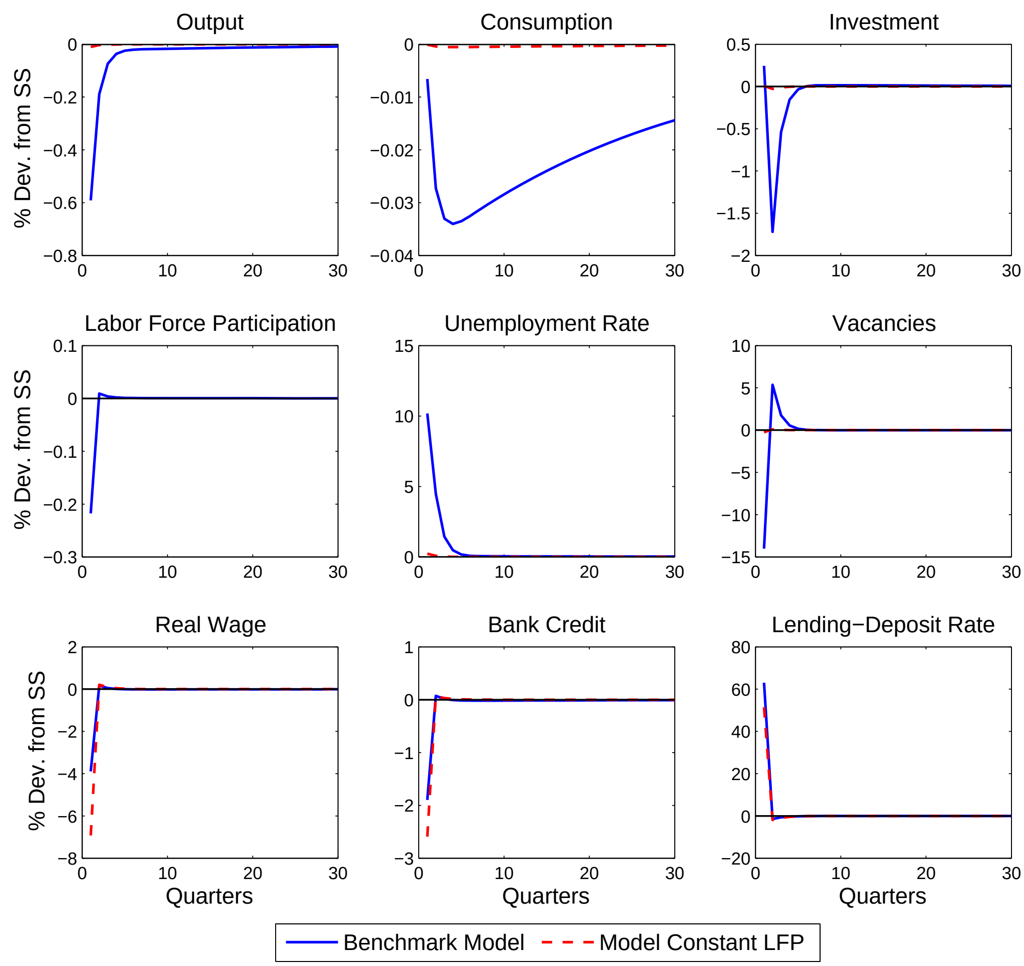

Figure 4: Response to a One Standard Deviation Reduction in Elasticity of Substitution of Loans ξ–The Role of Labor Force Participation

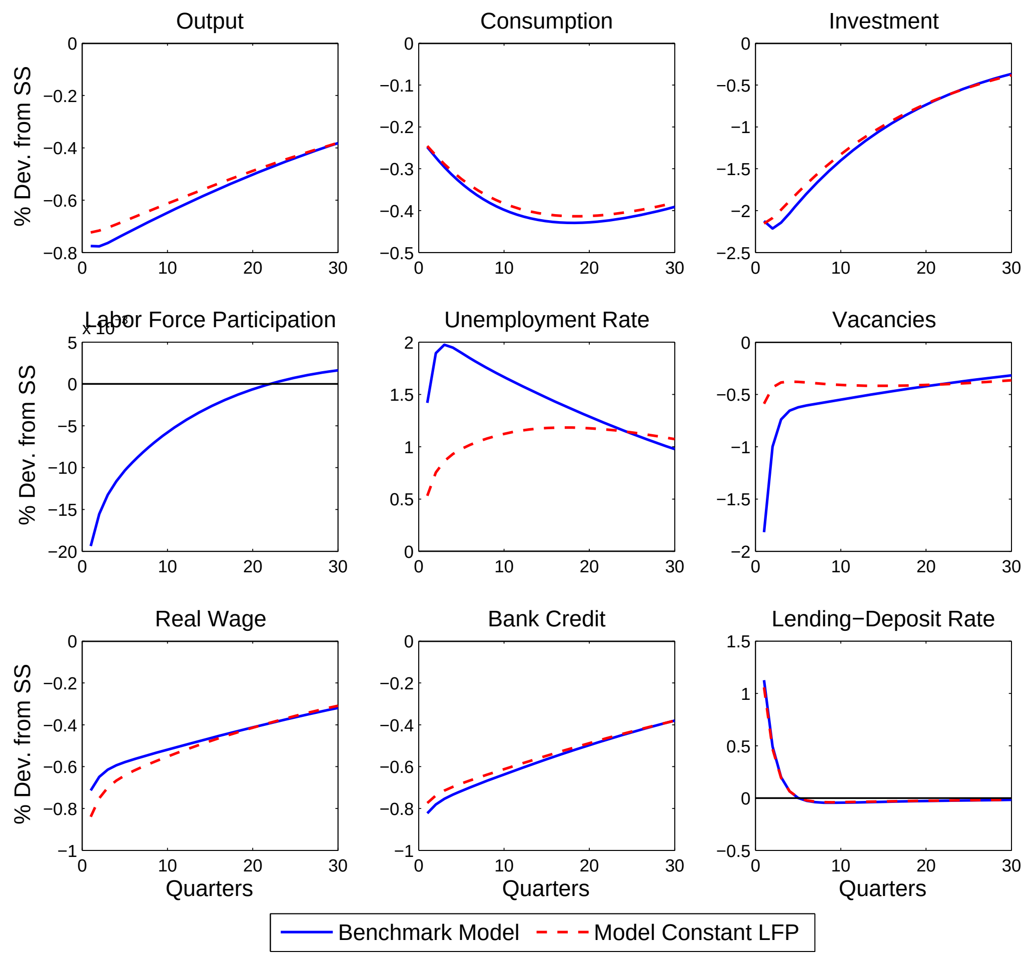

Figure 5: Response to a One Standard Deviation Reduction in Aggregate Productivity A–The Role of Labor Force Participation

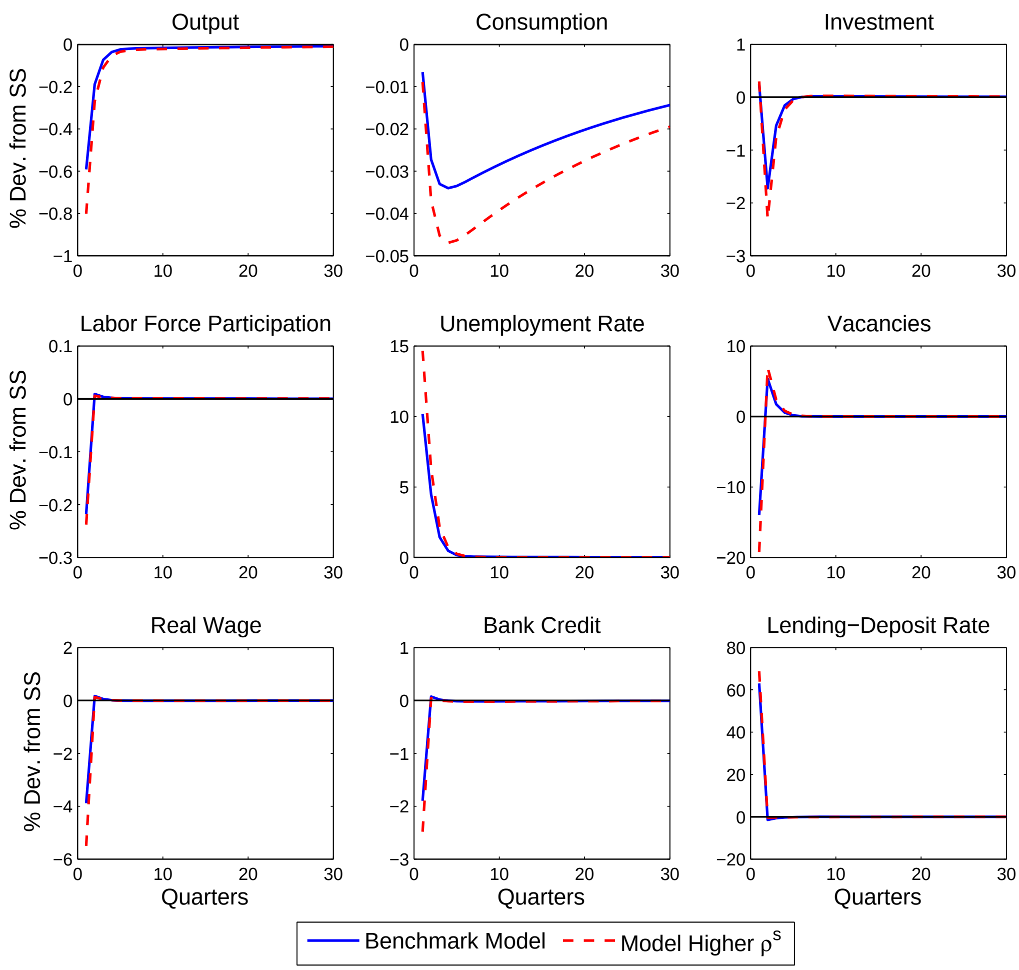

Figure 6: Response to a One Standard Deviation Reduction in Elasticity of Substitution of Loans ξ–The Role of Long-Lasting Loan Relationships

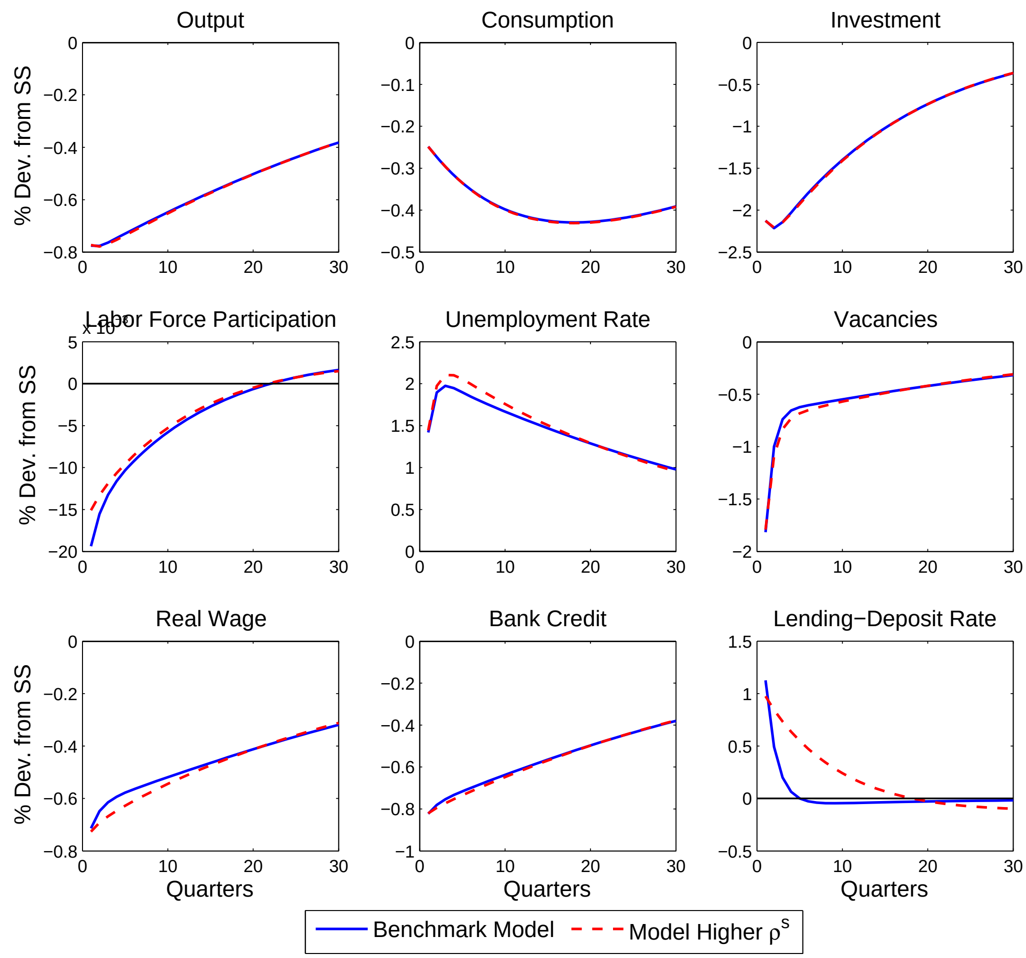

Figure 7: Response to a One Standard Deviation Reduction in Aggregate Productivity A–The Role of Long-Lasting Loan Relationships

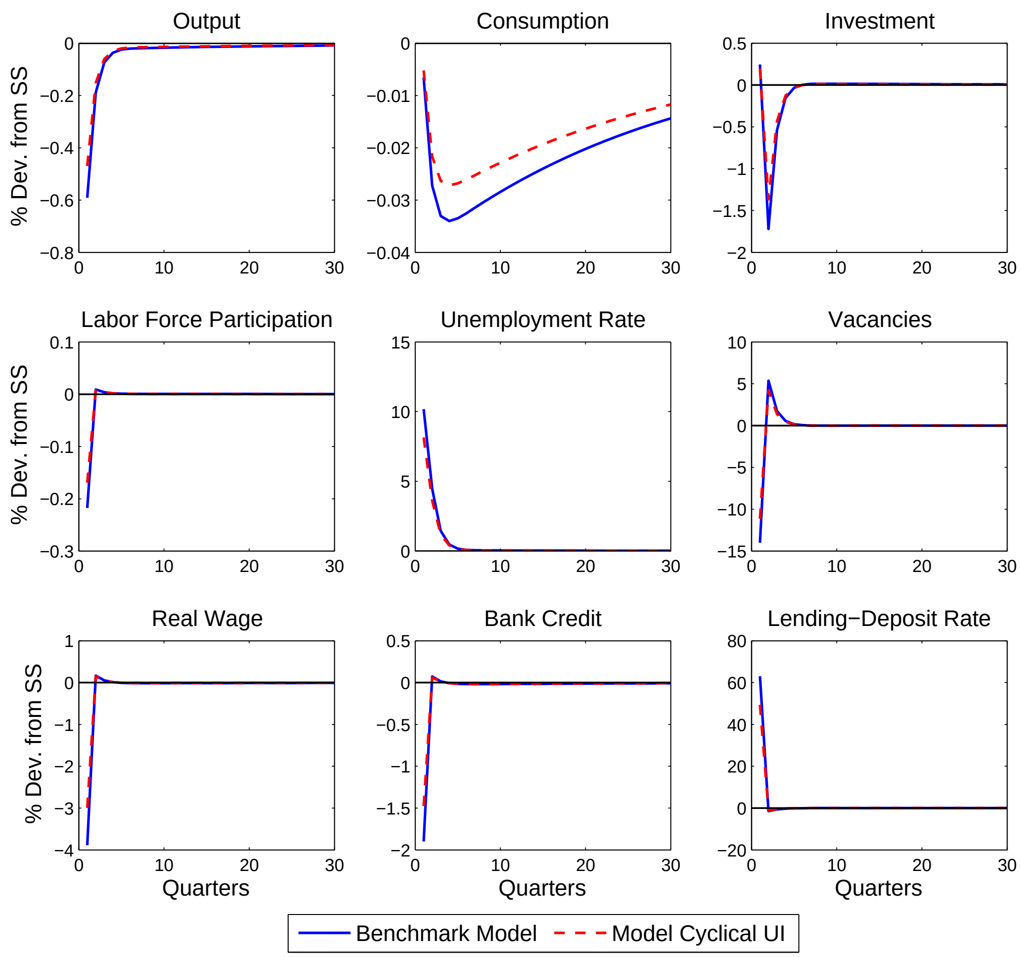

Figure 8: Response to a One Standard Deviation Reduction in Elasticity of Substitution of Loans ξ–Countercyclical Unemployment Insurance Benefits

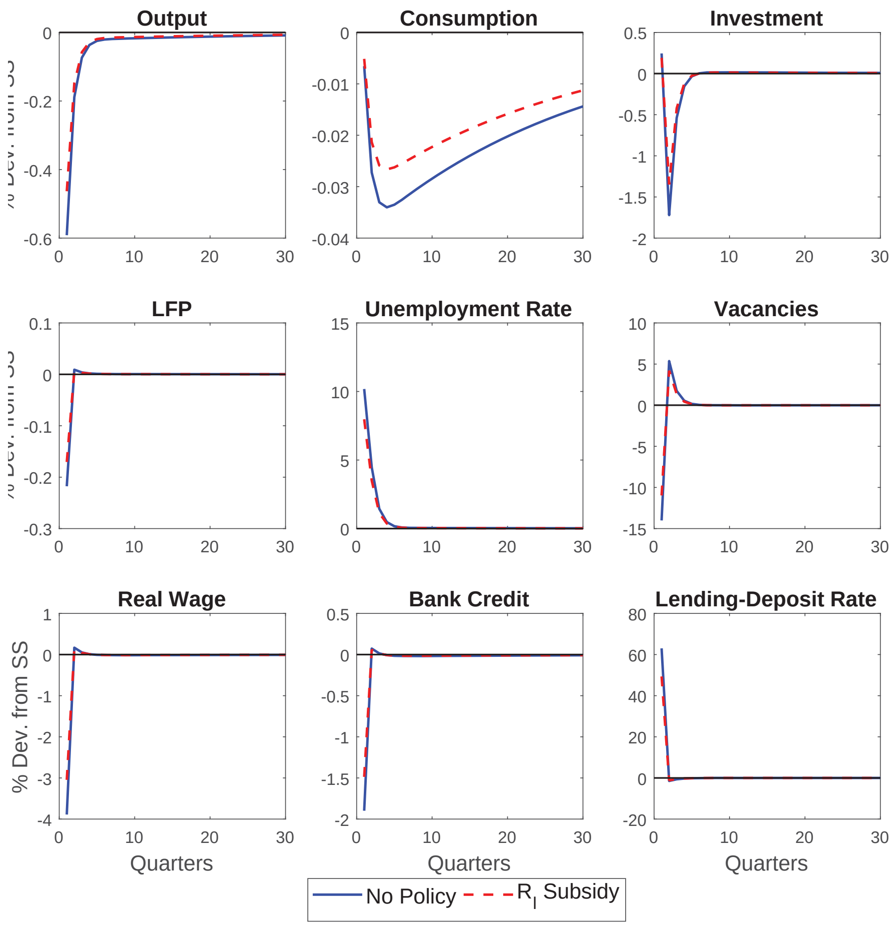

Figure 9: Response to a One Standard Deviation Reduction in Elasticity of Substitution of Loans ξ–Countercyclical Credit Subsidies

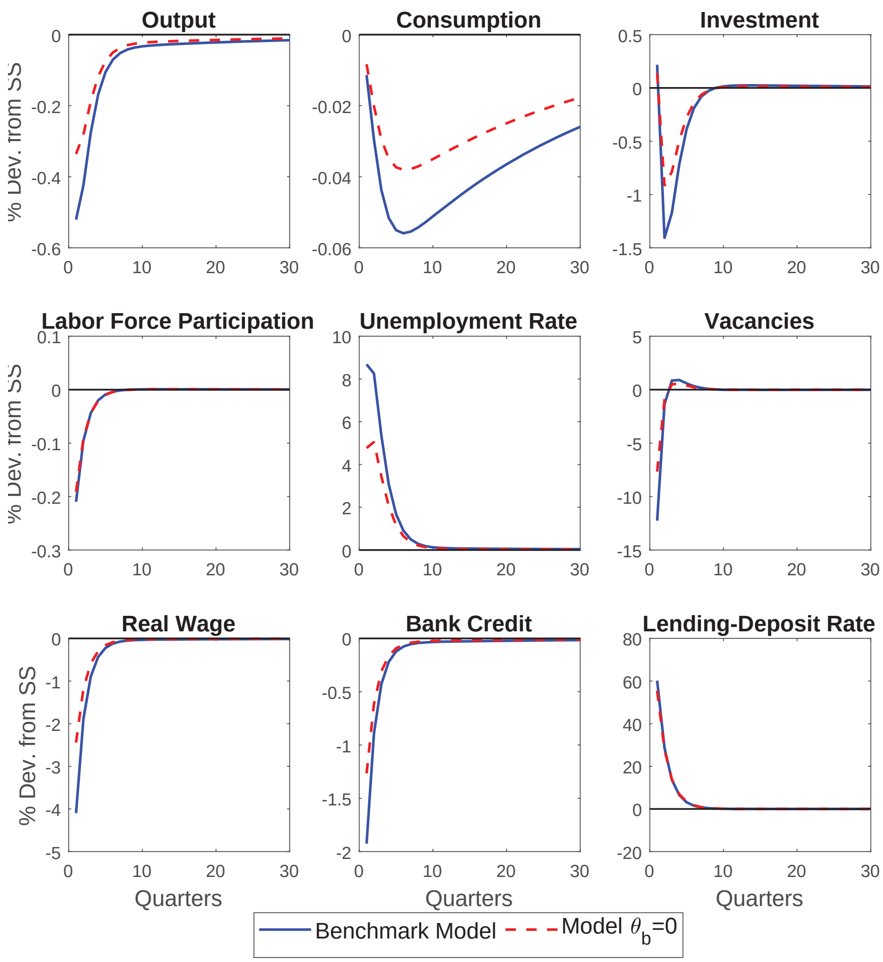

Figure A1: Response to a One Standard Deviation Reduction in Elasticity of Substitution of Loans ξ–The Role of Deep Habits in Banking (Persistent ξ Shocks)

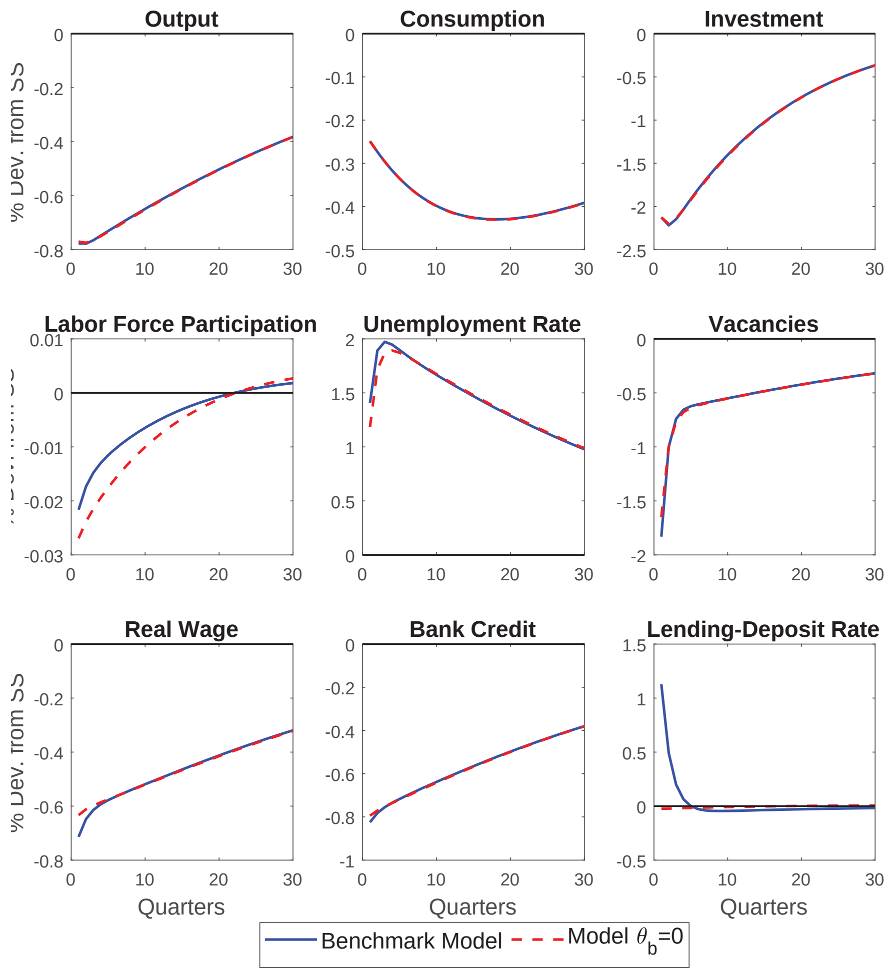

Figure A2: Response to a One Standard Deviation Reduction in Aggregate Productivity A–The Role of Deep Habits in Banking (Persistent ξ Shocks)

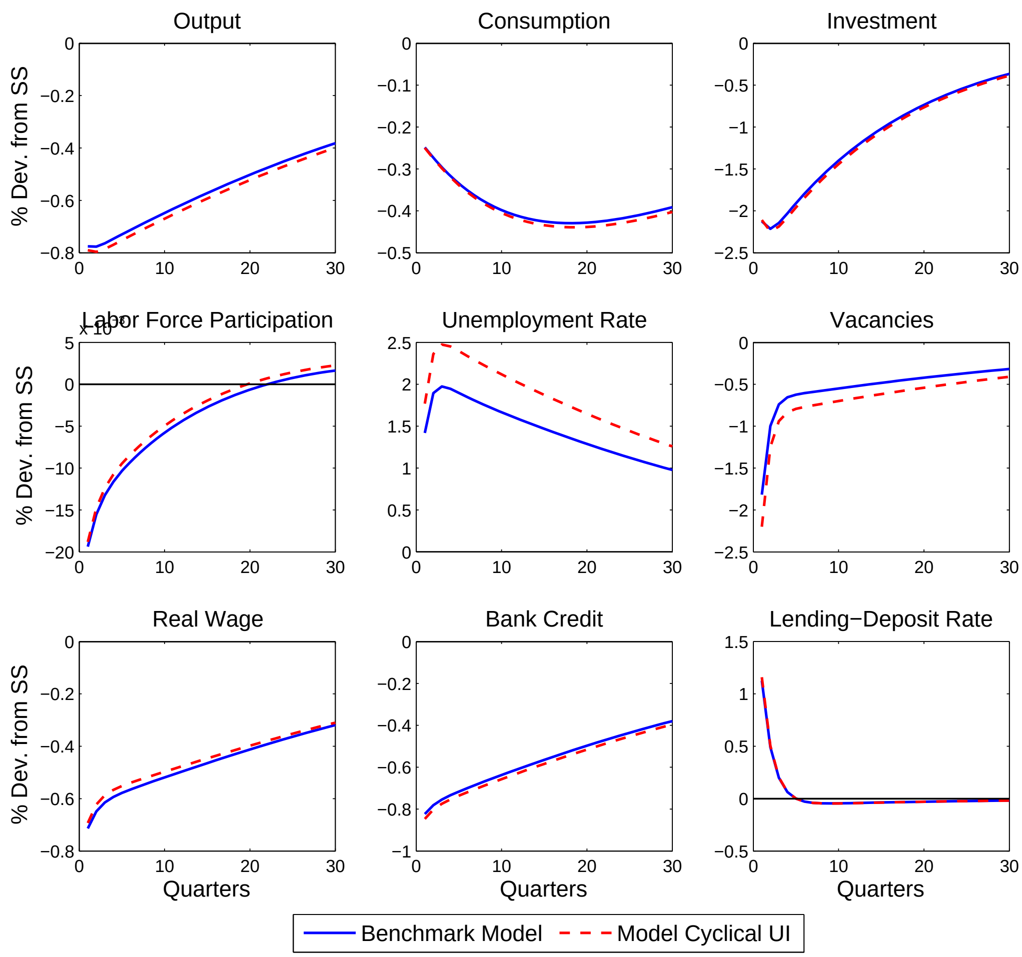

Figure A3: Response to a One Standard Deviation Reduction in Aggregate Productivity A—-Countercyclical Unemployment Insurance Benefits

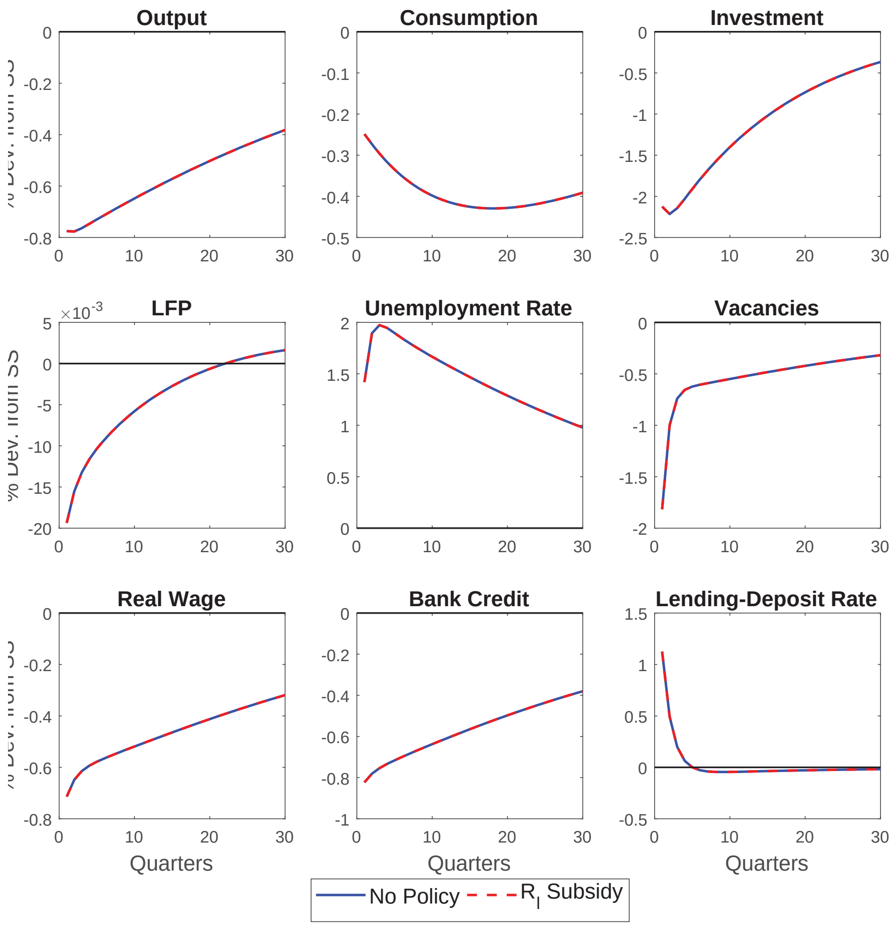

Figure A4: Response to a One Standard Deviation Reduction in Aggregate Productivity A—-Countercyclical Credit Subsidies