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Assessing Unconventional Monetary and Fiscal Policies

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Abstract

Unprecedented nature of the global financial crisis in 2009 forced policymakers to adopt unconventional policy measures which then became part of the policy tool set that was widely used during the Covid-19 pandemic. Utilizing a New Keynesian general equilibrium model with a rich fiscal structure and financial frictions, this paper provides a comprehensive cost-benefit analysis of two such policies; credit easing and bank capital injections. In contrast to much of the existing work on unconventional policy that predominantly focuses on the benefits of these measures, our work explicitly considers the cost of paying for each policy. Interestingly, we find that both unconventional measures are welfare improving even under distortionary taxes. Compared to credit easing, the use of bank capital injections has a greater stabilizing effect on the economy and generates higher welfare gains even with lower returns to equity supplied through the latter relative to the former.

JEL Codes: E44, E63, G21

Keywords: financial crises, credit easing, capital injections, welfare

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Geleneksel Olmayan Para ve Maliye Politikalarının Değerlendirilmesi

Öz

2009'daki küresel mali krizin benzeri görülmemiş doğası, politika yapıcılarını daha sonra Kovid-19 salgını sırasında da yaygın olarak kullanılan geleneksel olmayan, alışılmadık politika önlemlerini benimsemeye zorladı. Zengin bir mali yapı ve finansal sürtüşmeleri yapısında barındıran bir Yeni Keynesyen genel denge modeli kullanan bu makale, bu tür iki politikanın - kredi gevşemesi ve banka sermayesi enjeksiyonları - kapsamlı bir maliyet-fayda analizini sunmaktadır. Ağırlıklı olarak bu önlemlerin faydalarına odaklanan mevcut çalışmaların çoğunun aksine, bu çalışma her iki politikanın ödeme maliyetini açıkça dikkate almaktadır. Bulgularımız, kredi gevşemesi ile karşılaştırıldığında, banka sermayesi enjeksiyonlarının ekonomi üzerinde daha büyük istikrar sağlayıcı etkisine ve daha yüksek refah kazanımlarına işaret etmektedir.

JEL Kodları: E44, E63, G21

Anahtar kelimeler: finansal krizler, kredi genişlemesi, sermaye enjeksiyonları, refah

1. Introduction

The first two decades of the 21st century were dominated by two crises, both unprecedented in different ways. The first, the global financial crisis (GFC) in 2008-09, was widely viewed as the worst since the Great Depression in the 1930s regarding both the scale of the turbulence in the financial markets and the resulting output loss in economic activity. Although very different in nature, the Covid-19 pandemic in 2020, a once-in-a-century public health emergency, also quickly turned into a full-scale economic crisis. The collapse of demand on both occasions led policymakers to take exceptional measures; for example, by reducing interest rates to near zero levels during the GFC. This was supported by unconventional policies such as large-scale asset purchase programs pioneered by the US and UK in 2009, a policy that was utilized much more commonly during the Covid-19 pandemic including by the emerging economies (See, for example, Claessens et al. 2012; Bernanke, 2020; Dedola et al. 2021; and Cortes et al. 2022 among many others).

In this paper, we provide a comparative cost-benefit analysis of the two widely adopted unconventional measures: *credit easing* (provision of liquidity to the economy as a whole), and *bank capital injections* (direct support to financial institutions). To do so, we build a New Keynesian dynamic stochastic general equilibrium (DSGE) model with a rich fiscal structure as well as financial frictions in the banking sector. These frictions create an intertemporal distortion in the economy, resulting in a wedge between the gross return to risky assets and the gross riskless return, widely referred to as ‘credit spread’. We characterize credit easing in our model as a policy tool where the central bank raises the total credit in the economy by extending the supply of securities to non-financial firms. Bank equity injections, on the other hand, are modeled as a direct increase in bank capital.

As is standard in similar models with financial frictions, an unfavourable financial shock leads to a fall in asset prices, triggering the financial accelerator mechanism. As a result of the decline in asset prices, banks experience a deterioration in their balance sheets, leading to a jump in the leverage ratio and hence, in the credit spread. The rise in the spread, in turn, pushes up the cost of capital which reduces investment and asset prices further, thereby lowering aggregate output. When the policymaker pursues unconventional policies in the form of credit easing or bank capital injections, the rise in the credit spread is curtailed, hence the jump in the cost of capital, containing the fall in investment and thus in aggregate output. Due to the direct improvement in banks’ balance sheets, bank capital injections generate a much smaller increase in the leverage ratio and thus in the spread compared to that with credit easing. However, bank capital injections are also more expensive relative to credit easing given that the return to equity supplied by the former is lower than the return to securities intermediated by the latter.

Given that both the gains from and the costs of pursuing bank capital injections are greater than those from credit easing, quantifying welfare outcomes associated with each policy is essential in establishing the ranking between the two. Indeed, our welfare analysis reveals that when the two policies can be used in tandem, it is optimal to allocate all the funds to bank capital injections, arising from their greater effectiveness in mitigating the unfavourable effects of financial shocks. Relatedly, when policymakers utilise each policy in isolation, welfare gains from bank capital injections are greater than that from credit easing. Importantly, these results hold irrespective of the fiscal instrument used in paying for the credit policy. Our findings also indicate that working with lump-sum taxes as opposed to distortionary alternatives overstates the welfare gains from pursuing credit market interventions.

Our paper differs from the related previous studies in two key aspects. First, motivated by the lack of work on the cost of unconventional policies, we compare the fiscal costs, as well as the stabilizing effects of the two policies, and present a comprehensive cost-benefit assessment. The overriding focus of the existing work had been the effectiveness of unconventional policies in shielding the economy from the detrimental consequences of financial shocks.[1] Yet, the implementation of any credit policy also entails sizable costs, with important implications for the economy's response to the financial shocks, as highlighted by Benigno (2016) and Orphanides (2016). To assess the fiscal costs of alternative policy measures, we incorporate a rich fiscal structure where the policymaker has access to seven fiscal instruments: government consumption, public investment, transfers, lump-sum taxes, consumption taxes, labour and capital income taxes. This contrasts with the almost exclusive utilization of lump-sum taxes by much of the existing work on the effectiveness of unconventional policy. Yet, lump-sum taxes are rarely available to fiscal authorities in practice. Secondly, contrary to most other studies examining each credit policy in isolation, we provide a comparative analysis of these two widely adopted measures.

The rest of the paper is organized as follows. Section 2 sets out our benchmark model by describing the behaviour of the households, the financial sector, the production firms and the policymakers as well as the description of monetary, fiscal and credit policies. Section 3 presents our quantitative results, presenting impulse responses to a financial shock under the two credit policies. Section 3 also provides a welfare analysis of the two policies. Finally, Section 4 summarizes our main findings.

2. The model economy

Our framework is a monetary DSGE model featuring nominal rigidities á la Christiano et al (2005) and Smets and Wouters (2007) and a rich fiscal structure. It contains a banking sector that is characterized by credit frictions á la Gertler and Karadi (2011). Financial intermediaries face an agency problem, limiting their ability to borrow, which is at the core of the financial accelerator mechanism playing a key role in the adjustment in crisis periods.

Our model economy features seven types of agents: households (consisting of bankers and workers); three types of firms - capital goods producers, wholesale and retail firms; banks and the monetary and fiscal authorities.

We now turn to a detailed exploration of the behaviour of each agent.

[1] See, for example, Curdia and Woodford (2010), Del Negro et al. (2010), Gertler and Karadi (2011), Kollmann et al. (2012) and Hirakata et al. (2013).

2.1 Households

The population consists of a continuum of identical households of measure unity. The two types of members within the household are workers and bankers. Workers supply labour and earn wages while bankers manage financial intermediaries and transfer dividends back to households. Households keep their savings as deposits in the form of riskless one-period securities.

Households attempt to maximize expected discounted utility, given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t(C_t, C_{t-1}, L_t) \tag{1}$$

where $U_t = \frac{(C_t - \chi C_{t-1})^{(1-\varrho)(1-\sigma)}(1-h_t)^{\varrho(1-\sigma)} - 1}{1-\sigma}$, subject to the following budget constraint,

$$(1 + t_t^c)C_t = (1 - t_t^h)W_t h_t + (1 - t_t^k)\Pi_t + R_t D_{t-1} - D_t + TR_t \tag{2}$$

where $0 < \beta < 1$ is the subjective discount factor, E is the expectation operator, C_t denotes consumption and L_t leisure, W_t the wage rate, h_t $(=1 - L_t)$ hours worked, D_t bank deposits and R_t the gross risk-free deposit rate, set in period $t-1$ to pay out interest in period t. In equation (2) t_t^c and t_t^h denote the consumption and the labour income tax rate, respectively; Π_t dividend income from financial and non-financial firms; t_t^k the capital income tax rate; and TR_t is used for lump-sum transfers.

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2.2 Banks

We follow Gertler and Karadi (2011) in our characterization of the banking sector. A representative bank's net worth, n_t, evolves according to

$$n_t = R_t n_{t-1} + (R_{k,t} - R_t) Q_{t-1} s_{t-1} \tag{3}$$

where s_t denotes loans to non-financial firms, Q_t their price, R_t is the gross risk-free return and $R_{k,t}$ denotes the gross risky return to the bank's assets. The bank's net worth at t is composed of the gross riskless return plus the excess return on the bank's assets.

As standard, we maintain that with probability $1-\gamma$, a banker exists and becomes a worker. In addition, the same number of workers randomly become bankers.

Only upon exiting, the bank pays dividends. As a result, the banker's objective at the end of period t is to maximize the expected discounted terminal net worth, V_t:

$$V_t = E^t \sum_{i=1}^{\infty}((1-\gamma)\,\gamma^{i-1} \wedge_{t,t+i} n_{t+i} \tag{4}$$

where $\wedge_{t,t+i} = \beta \mathrm{U}_{C,t+i}\mathrm{U}_{C,t}$ is the real stochastic discount factor over the interval $[t, t+1]$. Given n_{t-1} at the beginning of period t, net worth in period t is determined by the choice of $\{s_{t+i}\}$.

The financial friction in the banking sector is based on a moral hazard problem between the banks and the households. After a bank obtains funds, the bank's manager may transfer a fraction, Θ, of total assets, $Q_t s_t$, for her own benefit. In this case, the bank defaults on its debt, and shuts down whereby the creditors reclaim the remaining 1-Θ fraction of funds. Given this possibility, households limit the funds (deposits) they lend to banks. As a result, the bankers' choice of s_t at any time t is subject to the following incentive constraint,

$$V_t \geq \Theta \mathrm{Q}_t s_t$$

That is, for depositors to be willing to lend to banks, the banker's loss from diverting funds should be at least as large as the gain from diverting assets and transferring them to the household he or she belongs.

We solve the banker's optimization problem using backward induction. Hence, we start by guessing that V_t can be expressed in the following form,

$$V_t = V_t(s_{t,} n_t) = \mu_{s,t} Q_t s_t + v_{d,t} n_t \tag{5}$$

where $v_{s,t}$ and $v_{d,t}$ are time-varying marginal values of loans and deposits, respectively and $\mu_{s,t} = v_{s,t} Q_t - v_{d,t}$ is the excess value of the bank's assets over its deposits.

Defining ϕ_t as the leverage ratio, the maximum ratio of a bank's assets to its net worth that satisfies the incentive constraint, we obtain;

$$Q_t s_t = \phi_t n_t \tag{6}$$

where $\phi_t = v_{d,t}\Theta - \mu_{s,t}$.

Using the solution to the banker's optimization problem, $v_{s,t}$, $v_{d,t}$ and $\mu_{s,t}$ are given as

$$v_{s,t} = E_t \wedge_{t,t+1} \eta_{t+1} R_{k,t+1} Q_t$$

$$v_{d,t} = E_t \wedge_{t,t+1} \eta_{t+1} R_{t+1}$$

$$\mu_{s,t} = E_t \wedge_{t,t+1} \eta_{t+1}(R_{k,t+1} - R_{t+1})$$

where $\eta_t = (1-\gamma) + \gamma(\mu_{s,t}\phi_t + \nu_{d,t})$ is the shadow value of a unit of net worth.

As the components of ϕ_t are not dependent on bank specific factors, we can sum across individual banks to obtain the aggregate banking sector balance sheet,

$$Q_t S_t = \phi_t N_t \tag{7}$$

where S_t denotes the aggregate quantity of bank assets and N_t reflects aggregate bank net worth.

The accumulation of aggregate net worth is given by the sum of the net worth of surviving bankers ($N_{o,t}$) and of new entrants ($N_{e,t}$), as given by:

$$N_{o,t} = \gamma(R_{k,t} Q_{t-1} S_{t-1} - R_t D_{t-1}) \tag{8}$$

$$N_{e,t} = \varepsilon(R_{k,t} Q_{t-1} S_{t-1}) \tag{9}$$

where ε is the fraction transferred to the new entrants.

Hence, the accumulation of net worth at the aggregate level can be expressed as:

$$N_t = R_{k,t}(\gamma + \varepsilon) Q_{t-1} S_{t-1} - \gamma R_t D_{t-1} \tag{10}$$

2.3 Firms

There are three types of firms: wholesale firms, retail firms, and capital producers whose characteristics are described in the following three sub-sections.

2.3.1 Capital producers

At time t, capital producers convert I_t of raw output into $(1 - S(X_t)) I_t$ of new capital, subject to the unit cost of investment, $S(X_t)$[2]. Hence, capital accumulation is given by:

$$K_t = \psi_{t+1}[(1-\delta) K_{t-1} + (1 - S(X_t)) I_t] \tag{11}$$

where K_t is the end-of-period capital stock, δ is the depreciation of capital, $X_t = I_t / I_{t-1}$, and ψ_t denotes the shock to the quality of capital, which follows an AR(1) process[3]:

$$\log \psi_t = \rho_\psi (\log \psi_{t-1}) + \varepsilon_\psi$$

where ρ_ψ denotes the autoregressive coefficient and ε_ψ is a white noise process with zero

[2] As is well-known, investment adjustment costs play a key role in the general equilibrium model's ability in matching the smoother investment responses observed in the data. See, for example, Smets and Wouters (2007). In our quantitative analysis, the investment cost function is of the following specific form: $S(X_t) = \phi x X_t^2$.

[3] The shock also affects the evolution of the bank's net worth. Accordingly, equation (10) would be rewritten as $N_t = R_{k,t}(\gamma + \varepsilon)\psi_t Q_{t-1} S_{t-1} - \gamma R_t D_{t-1}$.

mean and constant variance $\sigma^2_{\varepsilon_\psi}$.

The maximization of expected discounted profits by capital producers yields;

$$Q_t\big(1 - S(X_t) - X_t S'(X_t)\big) + E_t[\Lambda_{t,t+1} Q_{t+1} S'(X_{t+1}) X_{t+1}^2] = 1 \qquad (12)$$

a positive relationship between investment and asset prices, widely known as the Tobin's Q.

2.3.2 Wholesale firms

Wholesale firms produce output, Y_t^W, using the following Cobb-Douglas production function that contains labour and capital as factor inputs:

$$Y_t^W = Y_t^W(A_t, h_t, K_{t-1}, K_{t-1}^g) = (A_t h_t)^\alpha (K_{t-1})^{1-\alpha} (K_{t-1}^g)^{\sigma_g} \qquad (13)$$

where K_{t-1}^g represents public capital, σg is the elasticity of output with respect to public capital and A_t denotes aggregate productivity, which follows an AR(1) process:

$$\log A_t - \log A = \rho_a(\log A_{t-1} - \log A) + \varepsilon_A$$

Profit maximization by wholesale firms yields the following labour demand equation:

$$\frac{P_t^W}{P_t} Y_{h,t}^W W_t \qquad (14)$$

where P_t^W and P_t are the aggregate price indices in the wholesale and retail sectors, respectively, and where $Y_{h,t}^W = \alpha \frac{Y_t^W}{h_t}$. Equation (14) shows that the marginal product of labour equals the real wage. It also implies that labour demand increases with increases in output and the price of the wholesale output, while decreasing with an increase in wages.

A wholesale firm issues new securities to obtain funds from the banks, which are then used to buy new capital goods from capital producers. The number of claims issued by the firm, S_t is equal to the number of units of capital needed, K_t and its price:

$$Q_t S_t = Q_t K_t \qquad (15)$$

Due to perfect competition, wholesale firms earn zero profits, and they fully pay the return on capital to the banks, where;

$$R_{k,t} = \psi_t \frac{(1-\alpha)\frac{P_t^w Y_t^w}{P_t K_{t-1}} + (1-\delta) Q_t}{Q_{t-1}} \qquad (16)$$

Clearly, the return on capital is determined by the marginal product of capital, the capital quality shock, ψ_t, and the change in the price of capital, net of depreciation, δ.

2.3.3 Retail firms

Retail firms produce a basket of differentiated consumption goods. The demand for consumption is given by

$$C_t(f) = \left(\frac{P_t(f)}{P_t}\right)^{-\zeta} C_t \tag{17}$$

where $C_t(f)$ and $P_t(f)$ denote consumption and the price of the final good, respectively.

In aggregate, demand for investment, government expenditures and hence the final/retail output has the same functional form as consumption,

$$Y_t(f) = \left(\frac{P_t(f)}{P_t}\right)^{-\zeta} C_t \tag{18}$$

where ζ is the elasticity of substitution and the aggregate price index, Pt is given by $P_t = \left(\int_0^1 P_t\,(f)^{1-\zeta} df\right)^{1/(1-\zeta)}$.

Retail firms set their prices *á la* Calvo (1983). As a result, the optimal price-setting behaviour for the typical firm adjusting its price in period *t* is obtained by the maximization of the retailer's discounted nominal profits,

$$\mathrm{E_t} \sum_{\mathrm{k=0}}^{\infty} \theta^{\mathrm{k}} F_{t,t+k} Y_{t,t+k}(f)[P_t^a(f) - P_{t+k}\mathrm{MC_{t+k}}]$$

subject to equation (18). Here, θ is the probability that a firm cannot adjust its price in period *t*, *MC* is the real marginal cost, $P_t^a(f)$ is the adjusted price and $F_{t,t+k} = \beta^k \frac{U_{C,t+k}/P_{t+k}}{U_{C,t}/P_t}$ is the nominal stochastic discount factor over the period [*t*, *t* + *k*].

Under the given price-setting mechanism, the evolution of the price index is given by;

$$P_{t+1}^{1-\zeta} = \theta P_t^{1-\zeta} + (1-\theta)(P_{t+1}^a)^{1-\zeta} \tag{19}$$

where all is as defined earlier.

2.4 Monetary policy

We adopt a standard formulation for monetary policy. The central bank sets the gross nominal interest rate, $R_{n,t}$, according to a simple Taylor rule,

$$log\left(\frac{R_{n,t}}{R_n}\right) = \rho_\pi log\left(\frac{\Pi_t}{\Pi}\right) + \rho_y log\left(\frac{Y_t}{Y}\right) \tag{20}$$

where the steady-state nominal interest rate, inflation and output are given by R_n, Π and Y, respectively.

2.5 Credit policies

2.5.1 Credit easing

To model credit easing (henceforth *CE*), we follow Gertler and Karadi (2011) and maintain that the central bank can directly supply private securities (loans) to non-financial firms at the market lending rate, $R_{k,t}$. Unlike private financial intermediaries, the central bank is not balance sheet constrained and it can utilize the excess return on assets in times of financial distress. However, it faces an efficiency cost, τ^S, per unit of credit supplied to the market.

Under *CE*, loans to non-financial firms at the aggregate level are now given by the sum of privately intermediated securities, S_t^p and the securities that are intermediated via the central bank, S_t^g,

$$Q_t S_t = Q_t\left(S_t^p + S_t^g\right) \tag{21}$$

As in Gertler and Karadi (2011), securities intermediated by the central bank are financed by issuance of government bonds and are given by a fraction of total loans,

$$S_t^g = \varphi_t S_t \tag{22}$$

Accordingly, equation (7) takes the form of,

$$Q_t S_t = \phi_t N_t + \varphi_t Q_t S_t \tag{23}$$

2.5.2 Equity injections

To formalize bank capital injections (henceforth *BCI*), we maintain that the fiscal authority can support the central bank by injecting equity, E_t, into the banking sector and finance these injections by issuing government bonds. We normalize the units of government equity so that each unit of outside equity is a claim to the future returns of one unit of the asset that the bank holds. As a result, the return to a unit of government equity, $R_{e,t}$ is equal to $R_{k,t}$, the return on bank's assets.[4] In addition, the surviving bankers pay back the return on government equity the following period.[5] Accordingly, in the presence of *BCI*s, the accumulation of net worth is given by the following modified version of equation (10)

$$N_t = R_{k,t}(\gamma + \varepsilon)Q_{t-1}S_{t-1} - \gamma R_t D_{t-1} + E_t - \gamma R_{e,t} E_{t-1} \tag{24}$$

where the last two terms correspond to the increase in bank net worth with the injection, net of repayments. As with *CE*, government equity, E_t is set as a fraction of total bank equity,

$$E_t = \Upsilon_t N_t \tag{25}$$

and there are efficiency costs associated with government equity injections, equivalent to τ^N, per unit of equity supplied.

Securities intermediated by the central bank and capital injected by the government are determined as a fraction of total loans and total bank net worth, respectively. These fractions are given by φ_t and Υ_t, and they are set countercyclically, and hence, respond to the deviations of the credit spread from its steady-state value,

$$\varphi_t = \rho_\varphi\left[\left(R_{k,t} - R_t\right) - (R_k - \mathrm{R})\right]$$

$$\Upsilon_t = \rho_\Upsilon\left[\left(R_{k,t} - R_t\right) - (R_k - \mathrm{R})\right]$$

where ρ_φ and ρ_Υ indicate the intensity of unconventional policy.

2.6 Fiscal policy

In times of crisis, when credit policies are in place, government issues bonds, B_{t-1}^g, which are perfect substitutes for deposits, in financing total government intermediated assets, which are given by the sum of the fraction of loans intermediated by the central bank, $\varphi_{t-1}Q_{t-1}S_{t-1}$, and the fraction of bank capital injected by the government, $\Upsilon_{t-1}N_{t-1}$.

Accordingly, in crisis periods government budget constraint takes the form of

$$G_t^c + (1+\tau^S)\varphi_t Q_t S_t + (1+\tau^N)\Upsilon_t N_t + I_t^g + TR_t = T_t + R_{k,t}\varphi_{t-1}Q_{t-1}S_{t-1} + R_{k,t}\Upsilon_{t-1}N_{t-1} + B_t^g - R_t B_{t-1}^g \tag{26}$$

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[4] Given our calibration, this also ensures that the return on government equity in the model is equal to the expected rate of dividends under the Capital Purchase Program by the US Treasury. The expected rate of dividend income is presented in the Treasury's Capital Purchase Program Term Sheet for Privately Held Financial Institutions.

[5] Even though very few of the Federal Reserve's Commercial Paper Funding Facility (CPFF) beneficiaries failed in the period between 2008 and 2010, not all survived (Contessi and l-Ghazaly, 2011).

where G_t^c denotes government consumption, τ^S and τ^N efficiency costs of per unit of credit supplied through *CE* and of *BCI*, respectively, T_t total tax revenue in period *t*, B_t^g total government bonds outstanding in *t* and all else is as defined earlier. I_t^g denotes public investment which is subject to the following law of motion for public capital:

$$K_t^g = (1 - \delta)K_{t-1}^g + I_t^g$$

As formalised by the government budget constraint in equation (26), total government expenditure in period *t* consists of government consumption, public investment, lump-sum transfers, costs of supplying loans and injecting equity, $(1 + \tau^S)\varphi_t Q_t S_t + (1 + \tau^N)\Upsilon_t N_t$; and the gross riskless return, R_t that the government pays out on B_{t-1}^g. The government earns the gross risky return, $R_{k,t}$ from the loans supplied and the equity injected in period $t - 1$. Total government revenues also include proceeds from tax collection, T_t, which, in the benchmark case denotes lump-sum taxation. Distortionary taxation entails consumption taxes, labour income taxes and capital income taxes, $t_t^h C_t, t_t^h h_t W_t$ and $t_t^k \Pi_t$ respectively.

Evolution of each fiscal policy instrument is governed by a fiscal rule with an autoregressive component and a response to the deviations of government debt and aggregate output from their respective steady-state values[6]:

$$log\left(\frac{x_t}{x}\right) = \rho_t log\left(\frac{x_{t-1}}{x}\right) + \gamma_b log\left(\frac{B_t^g}{B^g}\right) + \gamma_y log\left(\frac{Y_t}{Y}\right) \quad (27)$$

where $x = \{T, t^c, t^h, t^k, TR, G^c, I^g\}$

3 Simulations and policy experiments

We now turn to our assessment of the two credit policies in moderating the unfavourable implications of a negative capital quality shock. In what follows, we first calibrate our model and then examine the responses of the economy to each shock under alternative policies.

3.1 Calibration

Given the prominence of both *CE* and *BCI* in the US policymakers' response to the GFC in 2009, we calibrate our model using data from the US economy (See, for example, Black and Hazelwood, 2013). Table 1 presents parameter values used in our calibration. We start by setting the financial parameters. In line with Gertler and Karadi (2011), we

[6] Cantore *et al*. (2019) and Leeper *et al*. (2010) show that such a specification for fiscal rules fits the data reasonably well.

choose the value of γ, the probability of bankers' survival, to ensure an average survival of 10 years for bankers. The ratio of transfers to the new entrants (ε) and the fraction of divertable bank assets (Θ) are calibrated to match an economy-wide leverage ratio of 4, and an average credit spread of 100 basis points per year, based on the pre-2007 spreads between BAA corporate and government bonds. We choose standard values for the labour share, α, the elasticity of substitution between goods, ζ and the value of the output elasticity of public capital, σ^{g}. The steady-state depreciation rate, δ, the habit persistence parameter χ, and the price rigidity parameter, θ are also set in line with the values used by Gertler and Karadi (2011).[7]

The parameters σ (in the utility function) and ϕ_X (in the investment cost function) are set to reflect the empirical literature (see, for example, Batini *et al*. 2011). For calibrating the discount factor, β and the preference parameter, ϱ, we adopt 0.35 for hours worked and 1.01 for the gross interest rate, as widely used in the analyses of the US economy. In setting the values for the tax rates and the ratios of government consumption and public investment to GDP, we follow Drautzburg and Uhlig (2015) and Trabandt and Uhlig (2011). We set the steady-state debt-to-GDP ratio to 60% in line with the level in the US before the global financial crisis, resulting in transfers at approximately 11% of output[8,9].

Given that monetary policy satisfies the Taylor principle, in order to yield determinacy in the model the fiscal instrument needs to adjust to stabilise the government's debt stock. When setting the fiscal policy parameters γ_b, γ_y, we take this factor into account and also choose the parameters such that the government initially runs a budget deficit, in line with the experience of the US following the global financial crisis. As in Gertler and Karadi (2011), we set the efficiency costs of unconventional monetary policy at 10 basis points and maintain this applies to both credit policies: $\tau^{S}, \tau^{N} = 0.0010$. We set the persistence parameter for the fiscal policy rule and the capital quality shock in our model to 0.75, following the conventional business cycle literature. The sensitivity of our results to the changes in the key parameter values is examined as part of our robustness checks.

[7] We include habit formation and investment adjustment costs in our analysis following from the existing evidence on the important role of real frictions in the ability of macroeconomic models to replicate the key properties of the business cycles in the US (Schmitt-Grohe and Uribe, 2007).
[8] See Leeper (2011) for a detailed explanation.
[9] Similar to Trabandt and Uhlig (2011), and Drautzburg and Uhlig (2015), the level of transfers is set through the calibration of other parameters in the government budget constraint.

Table 1. Calibrated Parameters

Households		
β	0.987	Discount factor
χ	0.7	Habit persistence parameter
ϱ	0.876	Preference parameter
Capital Producers		
ϕX	2	Coefficient of adjustment costs
δ	0.025	Depreciation rate
Wholesale Firms		
α	0.7	Labour share
σ^g	0.02	Output elasticity of public capital
Retail Firms		
ζ	7	Elasticity of substitution
θ	0.75	Probability of keeping prices unchanged
Banks		
γ	0.975	Probability that bankers survive
ε	0.001	Proportional transfer to the new entrants
Θ	0.410	Fraction of bank assets that can be diverted
Central Bank		
ρ_π	1.5	Inflation coefficient in the Taylor rule
ρ_y	0.5/4	Output gap coefficient in the Taylor rule
Government		
t^c	0.05	Consumption tax rate
t^h	0.28	Labour income tax rate
t^k	0.36	Capital income tax rate
G^c/Y	0.15	Government consumption-to-GDP ratio
I^g/Y	0.04	Public investment-to-GDP ratio
TR/Y	0.11	Transfers-to-GDP ratio
γ_b	0.05	Debt aversion coefficient in the fiscal policy rule
γ_y	0.5	Output gap coefficient in the fiscal policy rule

3.2 Policy experiments

In the following subsections, we examine the response of the model economy to a financial crisis with and without unconventional policies, by studying a set of macroeconomic outcomes under four policy regimes. In the first, the central bank follows a standard Taylor rule only. In the second and the third, the policymaker adopts either of the two credit policies, one at a time, and in the fourth, both credit easing and bank capital injections are utilized simultaneously.

3.2.1 The Financial Crisis

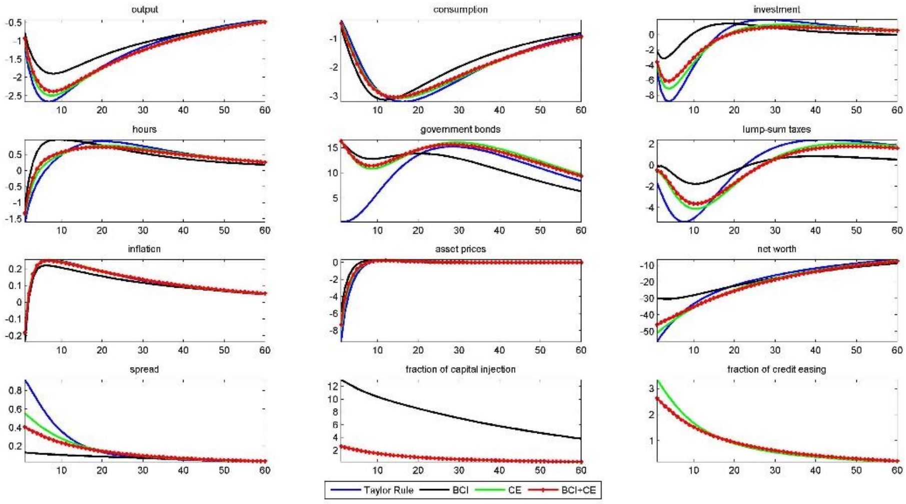
In our analysis, "financial crisis" refers to a series of events triggered by a negative capital quality shock, as in Gertler and Karadi (2011) and Karadi and Nakov (2021). We follow the former and set this to be equivalent to a five per cent deterioration in the quality of capital, which decreases the quality of the banks' assets and leads to an amplified fall in their net worth, due to high leverage. To ensure comparability, we set the initial gross fiscal cost of credit policies at 10 percent of the steady-state output, pinning down the coefficients ρ_φ and ρ_Y under CE and BCI, respectively. Given that our core focus is the fiscal implications of unconventional policies, we present a comparative analysis of costs versus benefits of the two credit policies under six scenarios varying according to the use of six separate fiscal instruments.

Benchmark case: lump-sum taxes

Under our benchmark scenario, as displayed by Figure 1[10], we maintain that the fiscal authority has access to lump-sum taxation. The profile of the crisis in this case is as follows. The deterioration in capital quality precipitates a decline in banks' net worth, leading to a fall in asset prices, thereby triggering the financial accelerator mechanism. Since banks are leveraged, the fall in asset prices results in a further worsening in net worth, that is amplified by a factor proportional to the leverage ratio. This deterioration makes it more difficult for banks to obtain funds from households. The resulting fall in the supply of credit and hence the rise in the spread pushes up the cost of capital. As a result, demand for capital falls leading to a further decline in investment and asset prices, resulting in a fall in aggregate output. The contraction in aggregate output, in turn, depresses labour demand, which, brings about a fall in inflation through a fall in wages and hence the marginal cost. The decline in aggregate output is also reflected in the reduction in aggregate consumption. The fall in inflation and output prompts the monetary authority to lower the interest rate.

[10] The vertical axes in Figures 1-6 demonstrate percentage deviations from the steady state, except for the fraction of *CE* and *BCI*, which present percentages.

Figure 1



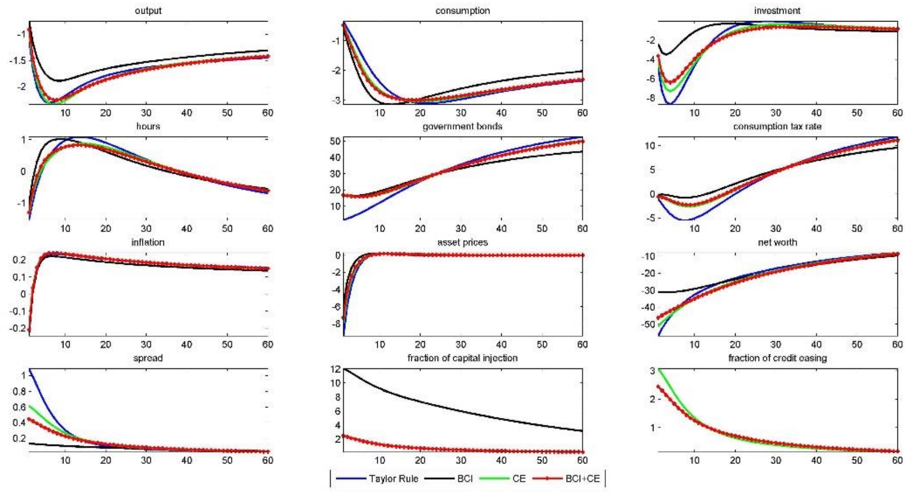
As can be seen from the top-left panel in Figure 1, the use of both credit policies moderates the unfavorable effects of the financial shock. When the central bank pursues *CE*, the supply of credit to non-financial firms rises, which in turn, contains the spike in the spread. Hence, firms are shielded from the full force of the disruption in the financial markets caused by the deterioration in banks' balance sheets. In contrast, *BCI*s directly enhance banks' net worth. As a result, the leverage ratio dampens, and bankers find it easier to acquire funds from depositors. This results in an increase in the supply of credit and a sharp reduction in the increase in the spread. Consequently, the increase in the cost of capital, the decline in investment, and in turn, the decrease in aggregate output are all curtailed. As can be seen from both the top-left and the bottom-left panels, the favourable effect of pursuing *BCI*s on aggregate output is visibly greater, arising from a much smaller rise in the spread compared to that under *CE*.

Figure 1 also reveals the increase in government bonds when the policymaker purchases private securities and bank equity. In contrast, in the absence of such credit policies government debt is built over time. Similarly, in response to the financial shock, the policy maker lowers taxes initially the most when no credit policy is in place. When there is equal funding for *BCI*s and *CE*, the resulting improvement in aggregate output is in between the levels obtained with the use of each policy in isolation, and so is the level of the initial decrease in taxes.

Policy responses with distortionary taxation

We now turn to the case of distortionary taxation which enables us to conduct a more realistic comparison of alternative credit policies. Figure 2 presents the economy's response to the same capital quality shock - a negative five per cent - where the fiscal authority has access to distortionary taxation and utilizes consumption taxes as the source of revenue to pay for the credit policies.

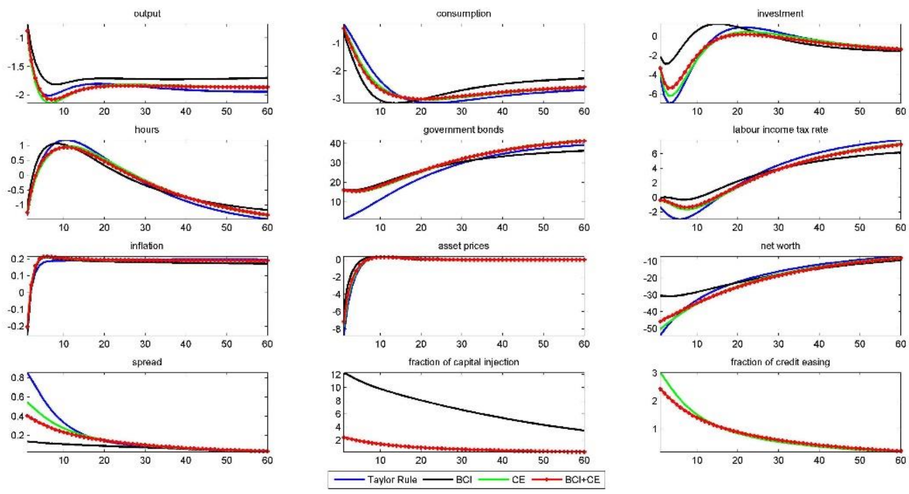
Figure 2



As can be seen from the last panel in the second row of Figure 2, compared to the case with no credit policy, BCIs (CE) generate(s) the smallest (largest) initial decrease in the consumption tax rate. Compared to the benchmark case, we observe a different set of consumption dynamics under the two credit policies where the initial decrease in consumption is amplified relative to the case with the Taylor rule. Consequently, the decline in consumption is most pronounced under BCIs. However, the use of BCIs still improves output the most, owing to the strength of investment (relative to all other cases), which, in turn results from the beneficial effect of BCIs on the spread, as can be seen in the bottom left panel.

Figure 3 repeats the same exercise for the case of distortionary labour taxes.

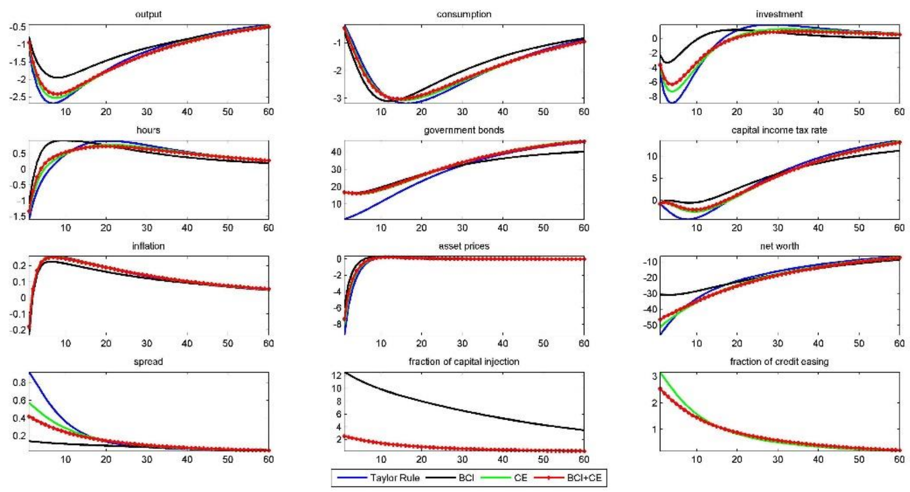
Figure 3



Compared with the case of lump-sum taxation, use of labour income taxes also induces an amplified initial decline in consumption under both BCI and CE. The dynamics of hours worked also vary with the different labour tax profiles obtained with BCI and CE. In addition, the improvement in output brought about by the credit policies shrinks significantly, resulting in lower output under CE compared to that under the Taylor Rule. This outcome highlights that the ability of unconventional policies in mitigating the negative effects of financial shocks are closely linked to the choice of the fiscal instrument used in paying for these policies.

Figure 4 displays the economy's response to the same shock when the government utilizes capital income taxes to respond to the changes in government debt and aggregate output.

Figure 4

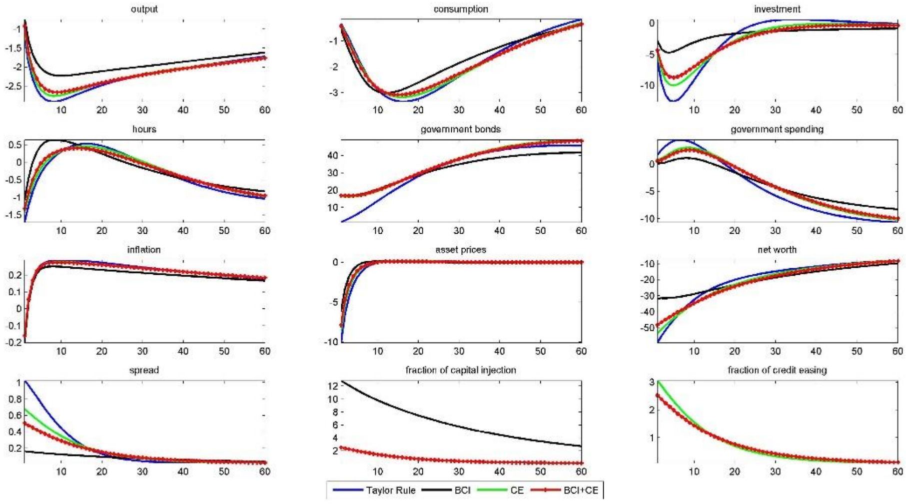


As can be seen from Figure 4, the magnitude of the initial decline in the capital tax rate under different policy alternatives is in line with our previous results: capital income tax rate is lowered the most under the Taylor Rule and the least under BCI. Yet, given that the dynamics of the capital tax rate do not have a significant impact on real activity, the aggregate output is similar to that obtained under lump-sum taxation. Overall, the use of the capital income tax is the least disruptive among all distortionary taxes.

Policy responses with public spending

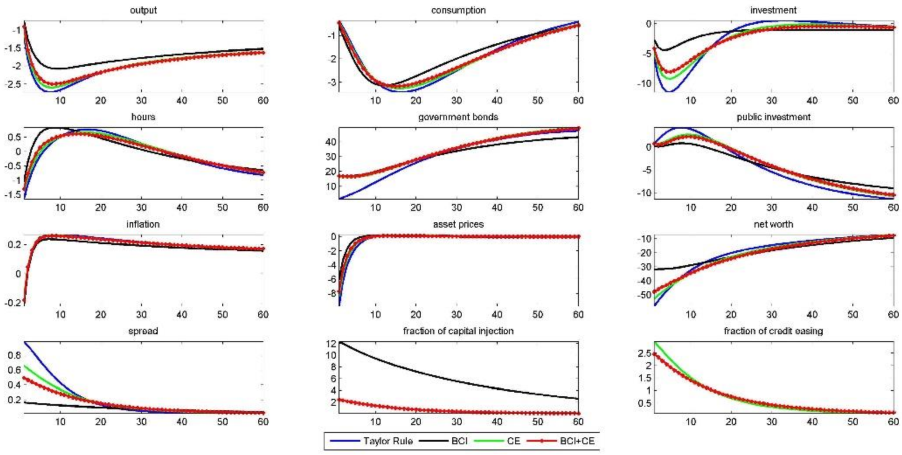
In this section, we turn to the cases where the fiscal authority utilizes public consumption or public spending as fiscal instruments in paying for the unconventional policies. Figures 5 and 6 exhibit the dynamics of the economy in the wake of the same capital quality shock when the fiscal instrument is government consumption and public investment, respectively.

Figure 5



The fiscal authority initially raises both types of public spending in order to stimulate the economy when hit by the financial shock. This is followed by a reduction in to ensure sustainability of government debt. The initial increase is the greatest under the Taylor Rule and the smallest with *BCI*, again owing to the fact that returns to *CE* are higher than returns to *BCI*. Compared with lump-sum taxation, there is a greater initial fall in consumption when credit policies are in place. Overall, the improvements in aggregate output obtained with the use of credit policies are overstated with lump-sum taxes and are the smallest when labour income taxes are used.

Figure 6



3.3 Credit policies and welfare

We now present a welfare analysis of the two credit policies. Following Schmitt-Grohe and Uribe (2007), we calculate welfare in each scenario using a second order approximation to the utility function. First, we state the household's utility function recursively,

$$V_t = U_t(C_t, C_{t-1}, L_t) + \beta E_t V_{t+1} \quad (28)$$

We take a second order approximation of V_t around the steady-state and calculate the second order solution to the model. We then compute the value of V_t, the welfare loss under each policy regime. While calculating the welfare losses, we use the policy parameters (ρ_π, ρ_y, ρ_t, γ_b, γ_y, ρ_Y, and ρ_φ) that optimize V_t in response to the capital quality shock. The welfare gains from using each alternative are then given by the difference between the values of V_t obtained under the Taylor rule alone and each credit policy alternative. We then compute the fraction of the steady-state consumption required to equate welfare under the Taylor rule to the one under each credit policy alternative - the consumption equivalent (*CEQ*).

Table 2 presents our welfare results under six scenarios varying across the fiscal instrument in paying for the credit policies: with lump-sum taxation (benchmark scenario); consumption taxes, labour income and capital income taxes, government consumption and public investment. To ensure comparability, we set the steady-state level of tax revenues to be equivalent across all scenarios.

Table 2. Welfare Gains with Lump-sum and Distortionary Taxes – CEQ(%)

	T	t^c	t^h	t^k	G^c	I^g
BCI	0.58	0.03	0.21	0.31	0.34	0.42
CE	0.12	0.00	0.00	0.06	0.07	0.08

We first observe that *BCI* generates higher welfare gains relative to *CE* under all scenarios. Using either of the public spending instruments increases welfare gains relative to that with distortionary taxes under both unconventional policies. It is also clear that capital income taxes dominate both consumption and labour taxes under both credit policies. In addition, among all the fiscal instruments considered, utilization of public investment results in the lowest decline in welfare gains compared to lump-sum taxation, for both policies.

Overall, three observations emerge from our welfare analysis: (i) *BCI*s are more effective in mitigating the unfavourable effects of financial shocks on the economy, resulting in better welfare outcomes in all cases; (ii) assessments based on lump-sum taxes overstates the welfare gains from pursuing credit market interventions; and (iii) except for the case with consumption and labour income taxes, benefits from using credit policies still outweigh the fiscal costs, resulting in positive welfare gains under both credit policies.

3.4 Sensitivity Analysis

In this section, we present a number of robustness checks. We start by examining the sensitivity of our results to the return on government equity.

3.4.1 Return to Government Equity

Our initial analysis maintains that the return on equity injected is the same as the return on loans supplied, $R_{k,t}$. We now consider the case where a unit of equity injected by the government has the return R_t; that is, the government does not earn a premium on bank equity. Table 3 presents welfare gains generated in response to the capital quality shock under *BCI*s, when banks pay R_t on government equity, instead of $R_{k,t}$ where benchmark values are also displayed as reference points.

Table 3. Welfare Gains under BCI with Different Returns– CEQ(%)

	T	t^c	t^h	t^k	G^c	I^g
$R_{k,t}$	0.5775	0.0248	0.2149	0.3058	0.3490	0.4250
R_t	0.6761	0.0496	0.4245	0.6033	0.4404	0.5210

Interestingly, Table 3 reveals that when the government earns a higher return on *BCI*s, the welfare gains from this policy are lower. This is mainly because it takes longer for banks to rebuild their net worth when they need to pay a higher return on the equity they receive. Consequently, without a premium on government equity, *BCI*s generate even higher welfare gains than *CE*, under all scenarios.

3.4.2 Efficiency Cost of Credit Policies

In our main welfare calculations, we set the efficiency costs of both credit policies at 10 basis points, $\tau^S = \tau^N = 0.0010$. Under this assumption, we showed that *BCI*s yielded better welfare outcomes with both lump-sum and distortionary taxes. Since the efficiency costs are a significant determinant of welfare outcomes, we now reexamine the relative welfare ranking of the two credit policies across a range of efficiency costs of *BCIs*.

Keeping the efficiency costs of *CE*, τ^S at 10 basis points, we find that an efficiency cost of *BCIs*, τ^N in the range of 50 to 300 basis points equates the welfare gains of *BCI*s to *CE*. The scale of this difference reinforces our key finding that *BCI*s are more effective than *CE* in mitigating the negative effects of financial shocks on the economy.[11]

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[11] However, it should be noted that for certain types of lending, for example, securitized high-grade assets such as mortgage-backed securities, the costs of *CE* might be lower than that of *BCI*.

3.4.3 Other Key Parameters

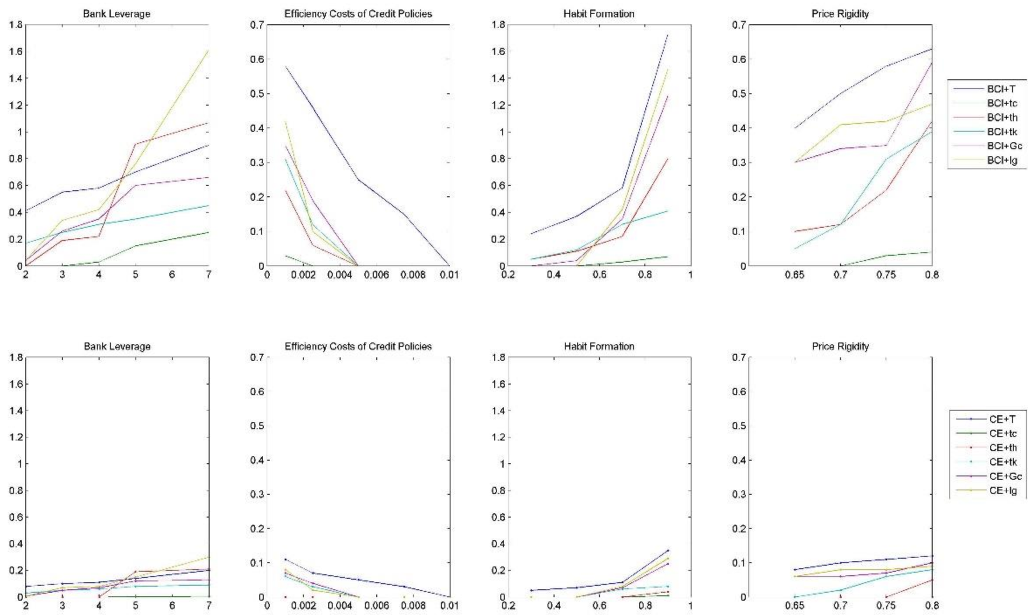
For the final sensitivity analysis of our results, we re-calculate the welfare gains by varying the values of the four key parameters in our model: bank leverage at the steady-state (ϕ), the efficiency costs of government intermediation, ($\tau^S = \tau^N$), habit persistence (χ), and price rigidity (θ). Figure 7 exhibits four cases displaying the consumption equivalent (CEQ) under varying values of the relevant parameter. In each case we present two rows: the first row for CEQs under BCI and the second row under CE, with each fiscal instrument, following a one percent negative shock to capital quality.

The first column of Figure 7 presents welfare gains across varying values of the bank leverage in the initial steady-state. An increase in the steady-state bank leverage corresponds to a fall in the fraction of bank assets that can be diverted. This, in turn, relaxes the bank's constraint, facilitating the accumulation of higher leverage. As the leverage ratio increases, the unfavourable effects of the financial shock are visibly amplified. As a result, both credit policies become more effective, yielding higher welfare gains, as shown in Figure 7. This is particularly the case when the government utilizes labour income taxes or public investment as the fiscal instrument.

The second column presents the variation in outcomes under the two credit policies for a range of values for the efficiency costs. As expected, welfare gains from credit policies fall as their efficiency costs increase. As before, *BCI*s generate higher welfare gains than credit easing at all levels of efficiency costs. Moreover, as efficiency costs of interventions increase distortionary fiscal instruments reduce the gains from the utilization of both credit policies more rapidly, compared to lump-sum taxes.

The third column displays the welfare gains for different values of the habit persistence parameter. As habit persistence rises both policies improve welfare more given that the use of the credit policies reduces the volatility of consumption. In line with our benchmark results, *BCI* yields higher welfare gains than *CE* and the use of other fiscal tools reduces welfare gains, compared to the case with lump-sum taxes.

Figure 7



4. Conclusion

This paper presented an assessment of the two most widely adopted credit policies since the global financial crisis in 2008-09; credit easing through direct lending to non-financial firms and bank capital injections through injecting capital into the financial sector. In contrast to the existing work on unconventional policy that predominantly focuses on the benefits of these measures, our work explicitly considers the cost of paying for each policy. Also importantly, particularly for a realistic policy evaluation, we move beyond the benchmark case of lump-sum taxation and investigate the interaction between different policy measures and different policy instruments. We conduct our analysis utilizing a New Keynesian DSGE model that contains a banking sector with financial frictions that play a key role in the amplifications of the effects of exogenous shocks.

We examine the dynamics of a financial crisis triggered by a capital quality shock. We find that the use of both credit easing and bank capital injections mitigates the unfavorable effects of the shocks on the economy by containing the rise in the spread. Compared to credit easing, the use of bank capital injections impacts aggregate output more favourably, through a direct improvement in banks' balance sheets, thereby significantly lowering the increase in the credit spread. However, bank capital injections also yield a lower return compared with credit easing. Hence, when the government injects capital into banks, more contractionary fiscal policy is adopted, with additional unfavorable consequences.

Our welfare results reveal that analyses based on lump-sum rather than distortionary fiscal instruments overstate the gains from pursuing credit market interventions. However, we also find that even in the presence of distortionary fiscal tools, bank capital injections generate welfare gains. The same result also holds for credit easing, except for the case of consumption and labour income taxes. Overall, bank capital injections dominate credit easing, due to the greater improvement in the spread under the former, the beneficial effects of which more than offset those of the fiscal surplus generated by the latter.

We also show that our results are robust to a wide range of variation in the parameter values. However, it is possible to envisage alternative frameworks where the assessment of the relative costs versus benefits might be different. For example, in the presence of sizable financial frictions benefits of credit policies would be substantial, while distortions in the tax system would imply that costs of these policies are also large. Our work, therefore, points to the key importance of analyzing the fiscal implications of unconventional policies. This is especially the case given that the existing empirical work has so far exclusively focused on the beneficial stabilizing role of these policies in the aftermath of the financial crises.

It should be noted, however, that our results rely on the assumption that the government does not default on its debt. If government bonds become subject to default risk, the ability to conduct unconventional policy would be significantly restricted, with serious consequences for the valuation of government bonds. We believe that incorporating the default risk for government debt in assessing post-crisis rescue programs is an important topic for further research.

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