Policy Experiments in a Minsky SFC Model

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Abstract. We develop and use a complete stock-flow consistent dynamic model to study and compare the effects of a variety of monetary and fiscal policies, including unconventional monetary measures and a job guarantee plan. We focus on a closed economy. We use two different formulations for the investment function (and the interest rate on loans), notably, a conventional formulation and a Minsky-like formulation. Our preliminary findings are as follows: *a*) Expansionary fiscal policies are strongly effective in reflating the economy when a conventional investment function is used (that is, when firms make their investment plans based on real accumulation needs). *b*) Fiscal policies are also effective when a Minsky-like investment function is used (that is, when investment decisions are influenced by the stock market valuation), although less effective than under the first scenario. *c*) Expansionary monetary policies are effective (reflationary) in the short run. However, they can have deflationary effects on the economy in the medium to long run, due to the fall in interest payments made by the government to the private sector. *d*) When a Minsky-like investment function is used, the effects of policy rate cuts and quantitative easing measures are weaker in the short run, but more persistent over time. *e*) A job guarantee plan is more effective than conventional spending in supporting employment, although the associated multiplier is lower. Its impact on the price level is ambiguous instead.

Keywords: Stock-Flow Consistent Models, Minsky Two-Price Model, Job Guarantee Plan

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1. Introduction

In this paper we develop and use a complete stock-flow consistent dynamic model to study and compare the effects of a variety of monetary and fiscal policies, including a job guarantee plan. The focus is on a closed economy. Two different formulations for the investment function (and the interest rate on loans) are used, notably, a conventional formulation and a Minsky-like formulation.

The next sections are organised as follows. Section 2 provides a general presentation of the model, along with a more detailed (equation-by-equation) explanation of its component parts. Section 3 defines the model baseline and presents the experiments. We compare conventional monetary and fiscal policies with unconventional measures, such as a quantitative easing program and a job guarantee plan. Our preliminary results are discussed in Section 4.

2. The model

The economy depicted by our model is quite complete. However, we made a few simplifying assumptions to reduce model complexity. As mentioned, the balance of payment is assumed away. Besides, the ecosystem is neglected, because we focus on short- to medium-run implications.[3] There are six sectors or "economic units" (households, production firms, commercial banks, central bank and government) and a variety of financial assets, including firms' securities (i.e. shares and/or corporate bonds). Output components are all expressed at constant prices. The behavioural equations for households are in line with SFC literature (e.g. Godley and Lavoie 2006), but differences in propensities to consume out of wealth components are explicitly considered. Building upon Minsky (1976, 1986) insights, investment decisions are based on the valuation ratio of firms, namely, the ratio of the market value of the firms in the stock market (which embodies the "borrower's risk", and is named "the demand price of capital assets" by Minsky) and their capital stock value (namely, the "supply price of capital goods"). The policy rate is set by the central bank. Commercial banks use a mark-up over the free-risk interest rate (which matches the policy rate). The risk premium increases as the lender's risk grows, that is, as firms' leverage ratio increases. The banks hold bills when *ex post* deposits exceed *ex post* loans. They demand advances (from the central bank) when *ex post* loans exceed *ex post* deposits. The government sector buys products from the firms. It also provides transfers to the private sector, mainly based on the unemployment rate. Tax rates are differentiated according to the sources of income.[4] Portfolio equations are based on Tobinesque principles. There are two forms of *narrow money*, namely cash and cheque accounts (M1) and one form of *broad money*, namely saving deposit accounts (M2) held with banks (which are financial assets with fixed nominal price). Saving deposits are the buffer stock of portfolio equations. Banks have no production costs and, unlike firms, distribute all the profits they make. There can be a reserve requirement. The central bank acts as a lender of last resort for the government and the commercial banks. However, the interest rate accruing on bills is (partially) endogenous, for it depends also on the private sector's demand for bills. Looking at the labour market, the supply of labour (i.e. the labour force) adjusts to the demand for labour inputs in the medium to long run. The wage rate is determined using a *wage equation* mechanism, from which the rate of change of real wage is related with changes in unemployment. The price level is defined by setting a mark-up over the unit cost of labour.

The formal model is made up of 72 equations, subdivided in nine blocks. We use the model to test a variety of monetary and fiscal policies, including an *employment of last resort* or *job guarantee* plan.

[3] However, a block of equations reproducing the interaction of the economy with the ecosystem has been developed. The *R* code of both the original model and its extension can be provided upon request.

[4] However, we attribute the same value to the two tax rates in the baseline scenario. See Table 1.

We do that by using two different formulations for the investment function (and the interest rate mark-up), notably, a conventional formulation and a Minsky-like formulation. We show that fiscal policies are always effective in reflating the economy, although they are more effective when investment is only based on *real accumulation* needs. By contrast, monetary policies are found to be remarkably more effective when firms' investment decisions are influenced by the stock market.

2.1 Production firms

The first equality comes from the national income identity (applied for a closed economy), which is:

$$y = c + id + gov \tag{1}$$

where y is GDP, c consumer expenditure, id private investment and gov government expenditure on goods and services (including public investment).

The standard way to model firms' investment behaviour in a SFC model is to define the target capital stock as a percentage of expected total income:

$$k^T = \kappa \cdot y \cdot \frac{ep}{p} \tag{2}$$

where κ is the desired capital to output ratio, ep is the expected price level and p is the actual price level.

Depreciation allowances are a percentage of firms' capital stock:

$$da = \delta \cdot k_{-1} \tag{3}$$

where δ is the depreciation rate of capital and k is its actual stock.

For the sake of simplicity, amortisation funds exactly match depreciation allowances:

$$af = da \tag{4}$$

Gross investment covers both the target change in capital stock and its depreciation:

$$id = \gamma \cdot (k^T - k_{-1}) + da \tag{5}$$

where γ is the speed of adjustment of current capital stock to its target value, k^T, which drives net investment plans (that is, firms' investment net of capital depreciation).

We compare equation (5) with an alternative formulation of the gross investment function, where firms' plans depend on the ratio of the demand price of capital assets to the supply price of capital goods. This ratio can be approximated by the valuation ratio of the firms (or Tobin's q), as expressed by their stock market value to their replacement cost:

$$q = \frac{esr \cdot pe + lf}{k} \tag{5A}$$

where esr is the amount of shares issued by the firms, pe is their unit price on the stock market and lf is the stock of obtained loans.

Therefore, the Minsky-like gross investment equation is:

$$id = \gamma_0 + \gamma_1 \cdot q_{-1} + da \tag{5B}$$

where γ_0 is autonomous investment, while q_1 is investment sensitivity to market valuation.

Whatever the investment function, the accumulation of capital over time is:

$$k = k_{-1} + id - da \tag{6}$$

Firms' profit is income minus interest payments minus amortisation funds minus wages, namely:

$$f_f = y - rl_{-1} \cdot lf_{-1} - af - wb \tag{7}$$

where rl is the interest rate on bank loans, lf is the stock of loans obtained by the firms and wb is total wage bill.

Distributed profits are a share of total profit:

$$fd_f = (1 - \theta) \cdot f_f \tag{8}$$

where θ is the retention rate on firms' profits. It is an exogenous variable of the model, which is autonomously set by the firms.

Retained profits are:

$$fu_f = \theta \cdot f_f \tag{9}$$

At the beginning of each period, bank loans are provided according to firms' demand to finance production (initial finance). Most of the loans will be repaid, though some of the bank deposits created remain in existence to satisfy households' demand to hold bank deposits. This means that, at the end of each period, the recorded change in the stock of bank loans demanded by the firms will equal the portion of investment that was not funded by internal funds (i.e. amortisation funds plus retained profits) or new issues of shares and other securities:

$$lf = lf_{-1} + id - af - fu_f - \Delta esr \cdot pe \tag{10}$$

The real quantity of new shares issued by the firms is calculated as a share of the investment:

$$esr = esr_{-1} + \chi \cdot \frac{id_{-1}}{pe_{-1}} \tag{11}$$

where χ is a positive coefficient.

2.2 Households

The disposable income of households is total income, including transfers, net of taxes:

$$yd = wb + rm_{-1} \cdot m2h_{-1} + rb_{-1} \cdot bh_{-1} + fd_f + f_b + tr - tax - rlh_{-1} \cdot lh_{-1} \tag{12}$$

where rm is the return rate on saving deposits, $m2h$ is the stock of saving deposits held by households, rb is the return rate on government bills, bh is their stock, rlh is the interest rate on mortgages, and lh is the stock of mortgages obtained by households.

New mortgages (net of repayments) are calculated as a percentage, ψ, of disposable income:

$$lh = lh_{-1} \cdot (1 - rep_{-1}) + \psi \cdot yd \tag{13}$$

where rep is the repayment rate of mortgages.

Total consumption depends on both expected disposable income and wealth components:

$$c = \alpha_1 \cdot yd \cdot \frac{ep}{p} + \alpha_2 \cdot hh_{-1} + \alpha_3 \cdot m1h_{-1} + \alpha_4 \cdot m2h_{-1} + \alpha_5 \cdot bh_{-1} + \alpha_6 \cdot eh_{-1} \tag{14}$$

where hh, $m1h$ and eh are the stocks of cash, cheque deposits and shares held by households, respectively. Each component of equation (14) is marked by a different propensity to consume. In line with the empirical evidence, it is assumed that: $\alpha_1 > \alpha_2 \geq \alpha_3 \geq \alpha_4 \geq \alpha_5 \geq \alpha_6$.

Besides, household propensity to consume out of income (α_1) is a function of income distribution (because the wage earners are assumed to have a higher propensity to consume relative to the rentiers) and the unemployment rate (because a higher unemployment is associated with higher uncertainty and perceived precariousness). The higher the income share to total income and the lower the unemployment rate, the higher the propensity to consume out of income:[5]

$$\alpha_1 = \alpha_{10} + \alpha_{11} \cdot \Omega_{-1} - \alpha_{12} \cdot un_{-1} \quad (15)$$

where $\alpha_{10}, \alpha_{11}, \alpha_{12} > 0$ and Ω is the wage share:

$$\Omega = \frac{wb}{y} \quad (16)$$

An alternative formulation of equation (15) is the following:

$$\alpha_1 = \alpha_{10} - \alpha'_{11} \cdot r^*_{-1} - \alpha_{12} \cdot un_{-1} \quad (15B)$$

where the policy rate, r^*, is used as an indirect measure of the non-labour income share. Equation (15B) is less elegant than equation (15). However, it reduces simultaneity in the model, while allowing for a nonlinear impact of the interest rate on output. Therefore, we use this alternative formulation in our simulations.

Household net wealth increases as households save. Revaluation effects (capital gains, cg) are also considered:

$$vh_n = vh_{n,-1} + yd + cg - c \quad (17)$$

Household *gross* wealth includes mortgages:

$$vh = vh_n + lh \quad (18)$$

Capital gains on shares are:

$$cg = esr_{-1} \cdot \Delta pe \quad (19)$$

where esr is the real stock of shares issued by the firms.

2.3 Commercial banks

Banks meet the demand for credit which is forthcoming at the market interest rates that they set, meaning that there is a sense in which the supply of loans meets the demand:

$$ls = lf + lh \quad (20)$$

Banks are willing to accept the deposits that the public wish to hold. This goes for both cheque accounts (M1), which bear no interest rate, and saving deposit accounts (M2):

$$m1s = m1h \quad (21)$$

[5] This mechanism reinforces upswings and downswings. The rationale is that the unemployed needs to save more, thus also affecting consumption plans of the employed through a variety of channels (imitation behaviour, conventions, uncertainty about future income flows, etc.)

$$m2s = m2h \tag{22}$$

Bank profits are received interests (on loans, mortgages, bills and reserves) minus interest paid on saving deposits and advances:

$$f_b = rl_{-1} \cdot lf_{-1} + rlh_{-1} \cdot lh_{-1} + rb_{-1} \cdot bb_{-1} + rh_{-1} \cdot (hbd_{-1} + hbd^*_{-1}) - rm_{-1} \cdot m2s_{-1} - ra_{-1} \cdot ad_{-1} \tag{23}$$

where bb is the actual stock of government bills held by the banks, hbd is the stock of reserves (based on deposits), hbd^* is the stock of extra-reserves, and ad is the stock of advances from the central bank, while rb, rh and ra are the related return rates.

Notice that the notional amount of bills held by banks is defined by the balance sheet identity:

$$bb_{not} = m1s + m2s - ls - hbd \tag{24}$$

There are two cases.

a) *Accepted deposits exceed granted loans and reserves*. The net stock of notional bills is held as Treasury bills and/or extra reserves:

$$\textit{if } bb_{not} > 0 \textit{ then } bb = \beta \cdot bb_{not} \tag{25}$$

$$\textit{and } hbd^* = (1 - \beta) \cdot bb_{not} \tag{26}$$

else $bb = 0$ and $hbd^* = 0$

where β is the share of Treasury bills to total notional bills, and $(1 - \beta)$ is the share of extra reserves, which add to legal (or other voluntary) reserves defined by equation (45).

b) Accepted *deposits are less than granted loans and reserves*. In this case, commercial banks need advances from the central bank:

$$\textit{if } bb_{not} > 0 \textit{ then } ad = 0 \textit{ else } ad = -bb_{not} \tag{27}$$

2.4 Government

The tax function is based on tax rates on labour income and capital incomes:

$$tax = \tau_0 + \tau_1 \cdot wb + \tau_2 \cdot \left(rm_{-1} \cdot mh_{-1} + rb_{-1} \cdot bh_{-1} + fd_f + f_b\right) + \tau_3 \cdot vh_{-1} \tag{28}$$

where τ_1 is the tax rate on labour incomes, τ_2 is the tax rate on capital incomes and τ_3 is the average tax rate on household property and wealth. We include also an autonomous component, τ_0, that captures exogenous shocks.

Government transfers depend on demographic factors (e.g. number of aged) and transfer rates (treated as exogenous) and unemployment benefits, which vary with the unemployment rate:

$$tr = \tau_4 + \tau_5 \cdot un_{-1} \tag{29}$$

where τ_4 is the amount of transfers that do not depend on unemployment, where τ_5 is the component that does depend on unemployment.

In addition to transfers, the government buys goods and services from the private sector. This additional government spending includes an autonomous component and a dependent component. An 'overt monetary financing' (OMF) to government spending is also included (gov_h), to be used for experiments:

$$gov = \sigma_0 + \sigma_1 \cdot y_{-1} + gov_h \quad (30)$$

where ρ_0 is autonomous spending and ρ_1 is the sensitivity of government spending to total income.

Notice that government expenditure is always *initially financed* by issue of money by the central bank. However, the formulation above allows for exploration of government expenditure that is designed to be central bank money funded only (gov_h).

Government deficit is government spending plus transfers plus interest payments minus taxes minus central bank profit:

$$def = gov + tr + rb_{-1} \cdot bs_{-1} - tax - f_{cb} \quad (31)$$

where bs is the supply of bills and f_{cb} is the profit made by the central bank. New bills are issued every time the government records a budget deficit, net of OMF government spending:

$$bs = bs_{-1} + def - gov_h \quad (32)$$

The stock of debt generated by OMF government spending is:

$$hg = hg_{-1} + gov_h \quad (33)$$

Looking at balance sheet implications, the central government debt amounts to bs, while the central bank holds an amount of Treasury bills that equals the monetised debt.

2.5 Portfolio decisions

Portfolio equations are based on Tobinesque principles. The portion of net wealth held in the form of each financial asset is defined by an autonomous component, the return rate on that asset (positive effect), the return rates on other assets (negative effect), and the disposable income to net wealth ratio (negative effect, except for cash). The latter is a proxy of the investors' liquidity preference. As a result, the demand for Treasury bills is:

$$bh = \lambda_{10} \cdot vh_{-1} + \lambda_{11} \cdot vh_{-1} \cdot rb_{-1} + \lambda_{12} \cdot vh_{-1} \cdot rm_{-1} + \lambda_{13} \cdot yd_{-1} + \lambda_{14} \cdot vh_{-1} \cdot re_{-1} \quad (34)$$

where λ_{10}, is the autonomous share of bills to total wealth held by the households, whereas λ_{11}, λ_{12}, λ_{13} and λ_{14} link the share of bills to total wealth with the return rate on bills, the return rate on saving deposits, money demand for transactions and the return rate on shares, respectively.

The demand for cheque deposits depends on both broadly defined transactions needs and the interest rates accruing on alternative financial assets:

$$m1h = \lambda_{20} \cdot vh_{-1} + \lambda_{21} \cdot vh_{-1} \cdot rb_{-1} + \lambda_{22} \cdot vh_{-1} \cdot rm_{-1} + \lambda_{23} \cdot yd_{-1} + \lambda_{24} \cdot vh_{-1} \cdot re_{-1} \quad (35)$$

where λ_{20}, is the autonomous share of cheque deposits to total wealth held by the households, whereas λ_{21}, λ_{22}, λ_{23} and λ_{24} link the share of deposits to total wealth with the return rate on bills, the return rate on saving deposits, money demand for transactions and the return rate on shares, respectively.

The demand price for equity and shares is:

$$pe = \frac{(\lambda_{30} \cdot vh_{-1} + \lambda_{31} \cdot vh_{-1} \cdot rb_{-1} + \lambda_{32} \cdot vh_{-1} \cdot rm_{-1} + \lambda_{33} \cdot yd_{-1} + \lambda_{34} \cdot vh_{-1} \cdot re_{-1})}{eh} \quad (36)$$

where λ_{30}, is the autonomous portion of shares to total wealth held by the households, whereas λ_{31}, λ_{32}, λ_{33} and λ_{34} link the portion of shares to total wealth with the return rate on bills, the return rate on saving deposits, money demand for transactions and the return rate on shares, respectively. [6]

The nominal amount of shares held by the households is:

$$eh = ehr \cdot pe \tag{37}$$

where the real quantity of shares that can be subscribed is defined by firms' issues:

$$ehr = esr \tag{38}$$

Household demand for banknotes (cash) is proportional to their expected consumption expenditures:

$$hh = \lambda_c \cdot c \cdot \frac{ep}{p} \tag{39}$$

Therefore, the saving deposit account is:

$$m2h = vh - hh - m1h - bh - eh \tag{40}$$

Saving deposits are the buffer stock of assets of household portfolio.

2.6 Central bank

The central bank acts as a lender of last resort for the Treasury, purchasing all the bills left unsubscribed by the private sector (households plus banks):

$$bcb = bs - bh - bb \tag{41}$$

The supply of cash equals central bank's holdings of bills plus the stock of money issued to fund OMF government spending plus the supply of advances minus reserves:

$$hs = bcb + hg + as - (hbs + hbs^*) \tag{42}$$

Cash yields no interest to the holder, whereas bank reserves can do so (as currently is this case in many countries). Advances are granted on demand:

$$as = ad \tag{43}$$

Central bank profit includes the seigniorage income flow on Treasury bills and received interests on advances, minus interest paid on reserves:

$$f_{cb} = rb_{-1} \cdot bcb_{-1} + ra_{-1} \cdot as_{-1} - rh_{-1} \cdot (hbs_{-1} - hbs^*_{-1}) \tag{44}$$

Banks hold reserves, and the demand for reserves may be derived from a legal reserve requirement or from banks precautionary demand. The demand for reserves is then modelled as:

$$hbd = \rho_1 \cdot m1s_{-1} + \rho_2 \cdot m2s_{-1} \tag{45}$$

where ρ_1 is the reserve ratio to cheque deposits and ρ_2 is the reserve ratio to saving deposits.

[6] Notice that λs are defined in such a way that: *a*) $\lambda_{i1} = -(\lambda_{i2} + \cdots + \lambda_{i4})$ for $i = 1,2,3$ (horizontal constraints on return rate coefficients for the i-th financial asset); *b*) $\lambda_{1j} + \lambda_{2j} + \lambda_{3j} = 0$ for $j = 1,2,3,4$ (vertical constraints for cross-asset return rate coefficients); and *c*) $\lambda_{10} + \lambda_{20} + \lambda_{30} < 1$ (vertical constraints for autonomous shares of assets to total wealth). The latter is lower than unity because households can also opt for cash and saving deposits.

Like advances, legal and voluntary reserves are supplied on demand:

$$hbs = hbd \tag{46}$$

The same goes for extra reserves:

$$hbs^* = hbd^* \tag{47}$$

2.7 Interest rates

The return rate on equity and shares is the ratio of distributed profits (dividends) to total holdings of shares:

$$re = fd_{f,-1}/eh_{-1} \tag{48}$$

The return rate on bills is defined using an endogenous mark-up over the policy rate:

$$rb = r^* + \mu b \tag{49}$$

While the *borrower's risk* is embodied in the valuation ratio of firms, the *lender's risk* is reflected in the mark-up over the free-risk interest rate on loans. For the sake of simplicity, we define the interest rate on loans as a linear function of firms' leverage ratio:[7]

$$rl = r^* + \mu l \tag{50}$$

where the mark-up, reflecting the lender's risk premium, is:

$$\mu l = \mu l_0 + \mu l_1 \cdot lev_{-1} \tag{50B}$$

Where μ_0 is an autonomous component and μ_1 is the sensitivity of the risk premium to firms' leverage ratio. The latter is defined as:

$$lev = \frac{lf}{esr \cdot pe + lf} \tag{50C}$$

Taken together, equations (50)-(50B)-(50C) imply that commercial banks increase the interest rate on loans as firms' insolvency risk increases. In principle, a higher interest rate on loans (linked with the higher lender's risk) depresses the economy in the short run (mostly due to the change in income distribution), but it raises the long-run steady-state level of output. However, the depressing effect is dominated by the boosting effect if the investment is highly elastic to the valuation ratio. In other words, a policy rate cut (increase) is associated with a long-lasting boom (slump) when firms' demand for capital goods is strongly influenced by the stock market. By contrast, the boom (slump) is only short-lived if firms' investment decisions are mostly based on *real accumulation* plans. As firms' behaviour is defined by the institutional structure of the economy they operate in, our model suggests that the net effect of the interest rate manoeuvre cannot be determined abstractally. In fact, it is mediated by many institutional factors.

The interest rate on mortgages is modelled as:

$$rlh = r^* + \mu lh \tag{51}$$

The return rate on saving deposits is:

[7] This is a simplification relative to the original Minskyan formulation, in which the lender's risk accelerates as the leverage ratio increases, so that: $d(\mu l)/d(lev) > 0$ and $d^2(\mu l)/d(lev^2) > 0$.

$$rm = r^* + \mu m \tag{52}$$

The interest rate on advances from the central bank is:

$$ra = r^* + \mu a \tag{53}$$

The return rate on reserves is:

$$rh = r^* + \mu h \tag{54}$$

These equations are general formulations based mark-ups and mark-downs on the policy rate of interest. In the modelling below (and reflecting current UK practice), the policy rate is treated as the interest rate paid by the central bank on reserves, and hence $\mu h = 0$ is used.

Bills' yield is depends on the private sector's demand for bills. The reason is that it is assumed that the central bank opts for the 'best bid'. As a result, the related mark-up over the policy rate is:

$$\mu b = \mu b_0 - \mu b_1 \cdot (bpr - bpr_{-1}) \tag{55}$$

where μb_0 is an autonomous component, μb_1 captures the effect of private demand on bond yield, and bpr is the share of bills demanded by the private sector:

$$bpr = \frac{bh+bb}{bs} \tag{56}$$

While the return rate on firms' securities is determined by market forces, the structure of the mark-ups is defined exogenously in such a way that:

$$0 = \mu h \leq \mu a \leq \ \mu m < \mu b_0 < \mu l \leq \mu lh$$

2.8 Labour market

The total wage bill paid by production firms to the workers (households) is:

$$wb = w \cdot nd \tag{57}$$

where w is the money wage rate and nd is labour demand. The latter depends on the production scale and the product per unit of labour in the private sector, prf:

$$nd = \frac{y}{prf} \tag{58}$$

The labour supply is treated as greater than or equal to labour demand, and hence there is generally unemployment and not any notion of over employment. Labour supply depends on an autonomous growth rate, but it also adjusts to firms' demand for labour inputs:

$$ns = ns_{-1} \cdot (1 + gl) + v \cdot (nd_{-1} - ns_{-1}) \tag{59}$$

where v tunes the speed of adjustment, while gl defines the autonomous or structural rate of growth of the labour force.

The actual unemployment rate is:

$$un = 1 - \frac{nd}{ns} \tag{60}$$

The nominal wage rate is determined through a linearised wage equation that links the expected percentage change in the real wage rate with the unemployment rate (in excess of the non-inflationary rate):

$$\frac{\frac{w}{ep}-\frac{w_{-1}}{p_{-1}}}{\frac{w_{-1}}{p_{-1}}} = \omega_1 \cdot (un_{-1} - nun)$$

hence:

$$w = [1 + \omega_1 \cdot (un_{-1} - nun)] \cdot \frac{ep}{p_{-1}} \cdot w_{-1} \quad (61)$$

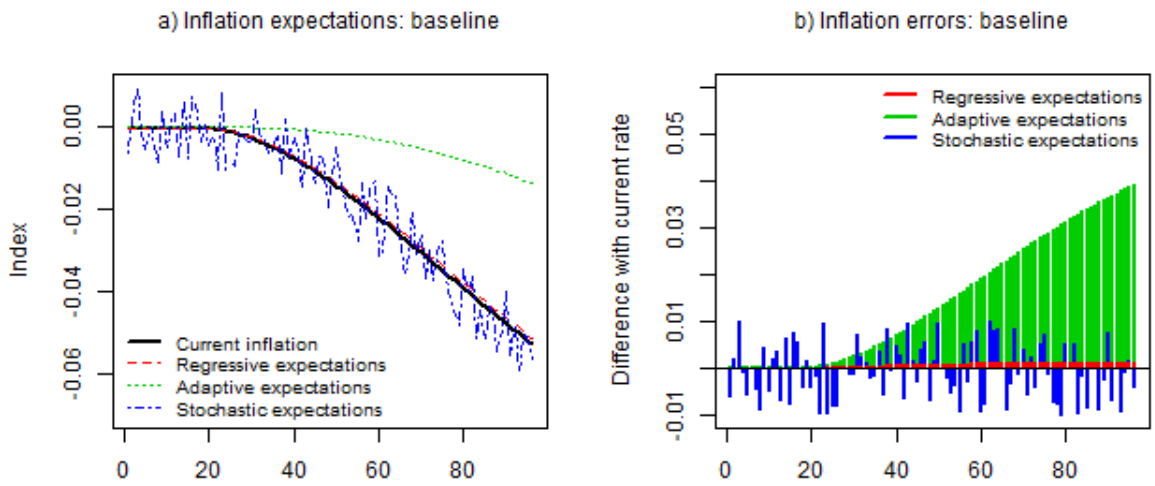
where ω_1 is wage sensitivity to unemployment rate gap with its non-inflationary rate, nun. Equation (61) holds that the lower the unemployment rate and the higher the expected price level, the higher the nominal wage rate.

2.9 Price level and inflation expectations

If we neglect the production of public goods, the general price level (p) equals the unit price of private output (pf), which is set by the firms using a mark-up over the unit cost of labour:

$$p = pf = \frac{w}{prf} \cdot (1 + \mu p) \quad (62)$$

Fig. 1. Inflation expectations: alternative mechanisms



The inflation rate is annual percentage change in the price level:

$$\pi = \frac{p}{p_{-1}} - 1 \quad (63)$$

We tried three different specifications of inflation expectations: adaptive, regressive and stochastic (or quasi-rational). The adaptive specification is:

$$E(\pi) - E(\pi_{-1}) = \psi_0 + \psi_1 \cdot [\pi_{-1} - E(\pi_{-1})] \quad (64)$$

where $\psi_0$and ψ_1 are positive coefficients. The regressive specification is:

$$E(\pi) - \pi_{-1} = \psi_0 + \psi_1 \cdot [\pi^T - \pi_{-1}] \quad (64B)$$

where π^T is the normal or target inflation rate (e.g. the central bank's target rate or the average inflation rate in the last 5 years).

Alternatively, quasi-rational expectations can be simply modelled as:

$$E(\pi) = \pi + \epsilon \tag{64C}$$

where ϵ is a random error, which has mean zero ($E(\epsilon) = 0$) and is uncorrelated with the information set that expectations are formed upon.

Whatever the inflation expectations specification chosen, the expected price level at period t is:

$$ep = p_{-1} \cdot [1 + E(\pi)] \tag{65}$$

The adjustment processes implied by different types of inflation expectations are displayed by Fig. 1. Notice that the regressive specification it the method that provides a more accurate approximation of how economic agents make their decisions in the real world (Sorić et al. 2019). Adaptive expectations do not fit available observations as regressive expectations do, while rational-like expectations are at odds with experimental findings. However, stochastic expectations bring about a stabilising effect on the model, because they do not depend on past inflation rates and are correct on average. We use regressive expectations in the experiments below.

2.10 Redundant equation

The redundant equation of the model is the equality between supply of cash, defined by equation (42), and demand for cash, defined by equation (39):

$$hs = hh$$

The equation above is not included because of the *Walrasian Law*, which states that 'any properly constructed model contains one equation that is redundant, in the sense that it is logically implied by the others' (Godley and Lavoie 2006, p. 107). In fact, it can be used to test the accounting coherence of the model. A visual representation of the redundant equation, used as a consistency check, is provided by Fig. 2(a).

2.11 A simple amendment to model quantitative monetary policies

The central bank can purchase financial assets from the private sector (Lavoie and Fiebiger 2018). In the real world, quantitative policies, such as the so-called *quantitative easing* (QE), aim to buy financial assets mainly from non-bank financial companies (McLeay et al. 2014). Since there are no financial intermediaries other than banks in our model, we assume that the central bank purchases financial assets directly from households.[8] While this change is likely to overestimate the quantitative effects of QE policies (if any) on the real economy (because it shortens the intermediation chain), there should be no qualitative differences. When the central bank sets the amount of Treasury bills to be bought from the household sector, equation (37) becomes:

$$bcb' = \max(\varepsilon \cdot bs_{-1}, bs - bcb - bb) \tag{41B}$$

where ε is the target ratio of bills to total supply of bills that the central bank is eager to subscribe. This ratio can be defined as a linear function of the policy rate, because it increases as the economy approaches the zero lower bound:

$$\varepsilon = \varepsilon_0 - \varepsilon_1 \cdot r^*_{-1} \tag{66}$$

[8] In principle, the central bank can buy bills directly from the commercial banks. However, this would have no effect on the economy in our model, apart from the impact generated by a reduction in bank profits (and a reduction in government deficit).

where ε_0 and ε_1 are positive coefficients. Equation (60) holds that, *ceteris paribus*, the target share of bills purchased by the central bank increases as the policy rate reduces.

As a result, households' net holdings of Treasury bills and cash at the end of the period may have to adjust to fit central bank purchasing programmes:

$$bh' = \min(\lambda_{10} \cdot vh_{-1} + \cdots + \lambda_{14} \cdot vh_{-1} \cdot re_{-1}, bs - bb - bcb) \quad (34B)$$

$$hh' = \max\left(\lambda_c \cdot c \cdot \frac{ep}{p}, hh + bh - (bs - bb - bcb)\right) \quad (39B)$$

The supply of cash varies to the same extent:

$$hs' = \max\big(bcb + hg + as - (hbs + hbs^*), hs + bh - (bs - bb - bcb)\big) \quad (42B)$$

When households reduce their holdings of Treasury bills, cash and/or deposits will increase to the same extent, thereby affecting reserves too. The implicit assumption is that the central bank can *force* the private sector to accept a higher amount of liquidity than initially planned (in exchange for less liquid assets) if the interest rate on deposits and reserves is low enough.[9]

2.12 A simple amendment to model a job guarantee plan

The role of the government as an employer of last resort was first mentioned by Minsky (1965). Minsky's proposal has been turned into a structured "job-guarantee" plan by the MMT theorists (e.g. Wray 2007). They argue that the government should provide a job to anyone who is able and willing to work in exchange for a compensation package. For this purpose, we amend the model to consider the job guarantee programme.[10]

Household demand for consumption now incorporates public goods and services produced under the job-guarantee plan. We define its aggregate value as the minimum between a constant share, α_g, of *total* consumption and the total cost of production of public goods of services:[11]

$$c_{gov} = \min\big(\alpha_g \cdot c, wb_g\big) \quad (67)$$

where wb_g is the wage will paid to the workers hired under the job-guarantee programme.

Firms' revenues from sales, hence profits, are now calculated net of household consumption of public goods:

$$f_f = y - rl_{-1} \cdot lf_{-1} - af - wb - c_{gov} \quad (7B)$$

Household disposable income and government deficit become, respectively:

$$yd = wb + rm_{-1} \cdot m2h_{-1} + rb_{-1} \cdot bh_{-1} + fd_f + f_b + tr - tax - (rlh_{-1} + rep_{-1}) \cdot lh_{-1} + \\ + wb_g \quad (12B)$$

and:

$$def = gov + tr + rb_{-1} \cdot bs_{-1} - tax - f_{cb} + wb_g - c_{gov} \quad (31B)$$

[9] For the sake of simplicity, we neglect corporate securities and we only focus on Treasury bills in in our experiments.

[10] Godin (2014) uses a SFC model to analyse the impact of a job-guarantee programme. However, unlike us, he focuses on the demand channel only.

[11] For the sake of simplicity, only non-durable goods and services are considered.

where:

$$wb_g = w_g \cdot ng \tag{68}$$

$$w_g = \rho_g \cdot w, \qquad \text{with: } 0 < \rho_g \leq 1 \tag{69}$$

$$ng = ng_{-1} + \delta_g \cdot (nn - ng_{-1}), \qquad \text{with: } nn = ns - nd \tag{70}$$

where ng is the number of employees under the job-guarantee programme and δ_g is the speed of adjustment of the programme size to changes in labour market conditions.[12]

Turning to the private labour market, firms' demand for workers is calculated using labour productivity and private output:

$$nd = \frac{y - c_{gov}}{prf} \tag{58B}$$

Similarly, the actual unemployment rate should not include those who are hired under the job-guarantee programme:

$$un = 1 - \frac{nd + ng}{ns} \tag{60B}$$

We assume that no mark-up is charged by the government over the unit cost of labour of public goods and services. In fact, the unit price of public goods (fares, tariffs, tickets, etc.) may well be lower than the average production cost (because $c_{gov} \leq wb_g$):

$$pg = \frac{c_{gov}}{prg \cdot ng}, \qquad \text{with: } prg \leq prf \tag{71}$$

where prg is the average labour productivity of public employees hired under the job guarantee programme.

We can now defined the general price level as a weighted average of private and public outputs' unit prices:[13]

$$p = pf \cdot \left(1 - \frac{c_{gov}}{y}\right) + pg \cdot \frac{c_{gov}}{y} \tag{72}$$

If there is sufficient productive capacity to provide job-guarantee employment, and all those without work intend to accept the job, then there must be no unemployment in the system in the medium run.[14] The tendential full employment brings about two opposite effects on wages and prices. On the one hand, it may push upwards the market wage rate. Besides, the propensity to consume increases and so does current aggregate demand – see equation (15). On the other hand, public goods are usually "cheaper" than private goods. Despite we assumed a lower product per worker, the lower wage rate and the zero-profit policy keep the unit price of public goods down. This helps counter inflation tendencies as the share of government output to privately-produced goods increases.

[12] Notice that equation (16) must be amended to include the government wage bill.

[13] We have used the public goods to total output ratio of the *past period* in our simulations to calculate the weights in equation (72). This allows us to avoid excess simultaneity.

[14] An additional assumption here is that the unemployed accept to work at (or below) the minimum wage. Notice that those who were relatively highly paid, before being fired, may decide to use time looking for other jobs.

3. Baseline and experiments

The model is run through 100 periods. Coefficients and initial values of variables are displayed by Tab. 1. The redundant equation is met, showing that the model is fully consistent. Fig. 2(b) shows that output components (expressed at constant prices) grow at a decreasing rate under the baseline scenario (with a standard investment function). There is no tendency for the interest rates to equalise – Fig. 2(c). There is perfect capital circulation, but not perfect asset substitution. Households choose their portfolios based on transaction needs for money, relative return rates from assets and other factors (captured by the autonomous component of portfolio equations). The baseline portfolio is shown by Fig. 2(d).

Seven policy options are tested in the next few pages, namely:

1. An increase in government spending funded by bills and money issues (σ_0 from 5 to 8).
2. An increase in government spending funded by money issues only (gov_h from 0 to 3).
3. A cut in the policy rate (r^* from 0.02 to 0.01).
4. A (major) change in the reserve requirement (ρ_2 from 0.005 to 0.75!).[15]
5. A quantitative easing programme (ε_0 from 0 to 0.50).
6. An "employer of last resort" policy or "job guarantee" plan (up to 1.5% of current output, see note 16).
7. A tax cut funded by bills and money issues (τ_0 from 0 to -3).

We allow model variables to stabilise before introducing alternative scenarios. Shocks are all run starting in period 60 from the baseline case.

4. Preliminary findings

Figures 3 to 6 display the qualitative impact of the policy options 1 to 6 on selected variables. Key findings are listed below:

a) Expansionary fiscal policies are strongly effective in reflating the economy when a conventional investment function is used (that is, when firms make their investment plans based on "real" accumulation needs only).
b) Fiscal policies are also effective when a Minsky-like investment function is used (that is, when investment decisions are influenced by the stock market valuation), although less effective than under (a).
c) Expansionary monetary policies, be they conventional (lower policy rate) or unconventional (QE), are reflationary in the short run. However, they can have deflationary effects on the economy in the medium to long run. When a Minsky-like investment function is used, these policies are less effective in the short run, but more persistent over time.
d) A job guarantee plan is more effective than conventional spending in supporting employment (see figures 5 and 6), although its impact on output (multiplier) is lower. The net effect on the general price level is ambiguous: unit prices of private goods increase, but, in principle, this can be counter-balanced by the provision of "cheap" public goods and services.[16]

[15] Unlike the other shocks, this change is expected to affect negatively the economy. The reason we test an increase (rather than a decrease) in the reserve requirement is that ρ_1 and ρ_2 have a floor (the zero level, which is quite close to the baseline value) but no ceilings. Besides, the effects are expected to be symmetrical within a reasonable range of other coefficient values.

[16] To make alternative policy options comparable, the experiments shown by figures 5 and 6 are based on the assumption that the government can spend up to 1.5% of current output (based on the last pre-shock output

e) A tax cut is less effective than government spending policies in reflating the economy.

5. Concluding remarks

We developed a complete stock-flow consistent dynamic model of a closed economy with Minskyan characteristics. A financially sophisticated environment is considered, where a variety of financial assets are traded, and where the central bank acts as a lender of last resort for both the government sector and commercial banks. The supply price of output, including capital goods, is set using a mark-up rule. However, the investment function can incorporate the demand price for capital assets (or stock-market valuation), hence the so-called borrower's risk, while the risk premium over the risk free interest rate is affected by the lender's risk. The model is used to study and compare the effects of a variety of monetary and fiscal policies, including a job guarantee plan. Our key, though preliminary, findings are as follows. Expansionary fiscal policies are more effective if firms' investment plans do not depend on the stock-market valuation. By contrast, expansionary monetary policies are more persistent over time if firms' decisions depend on the stock-market valuation. However, these policies can turn deflationary in the medium to long run (in a closed economy), because of the lower interest payments from the government to the private sector. A job guarantee plan is more effective than conventional spending in supporting employment, although the impact on output is lower. Its net impact on the general price level is ambiguous instead.

value) to fund either a conventional spending plan or a Job Guarantee plan. The salary paid by the government can never outstrip the wage rate paid in the private sector and reduces indefinitely as the number of people who apply to a government job increases. Notice that, if we introduced a minimum wage level paid by the government, the Job Guarantee budget would increase sharply relative to the baseline.

References

[1] Godin, A. 2014. Job Guarantee: a Structuralist Perspective. *Revue de la regulation*. 16(2e), pp.1-27 (online).

[2] Godley, W. and Lavoie, M. 2006. *Monetary economics: an integrated approach to credit, money, income, production and wealth*. Springer.

[3] Lavoie, M. and Fiebiger, B. 2018. Unconventional monetary policies, with a focus on quantitative easing. *European Journal of Economics and Economic Policies: Intervention*, 15(2), pp.139-146.

[4] McLeay, M., Radia, A. and Thomas, R. 2014. Money creation in the modern economy. *Bank of England Quarterly Bulletin*, Q1.

[5] Minsky, H.P. 1965. The Role of Employment Policy. *Hyman P. Minsky Archive*. 270. https://digitalcommons.bard.edu/hm_archive/270

[6] Minsky, H.P. 1976. *John Maynard Keynes*. Springer.

[7] Minsky, H.P. 1986. *Stabilizing an unstable economy*. McGraw-Hill.

[8] Sorić, P, Lolić, I, Matošec, M. 2019. Some properties of inflation expectations in the euro area. *Metroeconomica*, pp.1-28. https://doi.org/10.1111/meca.12273

[9] Wray, L.R. 2007. Minsky's Approach to Employment Policy and Poverty: Employer of Last Resort and the War on Poverty. *Levy Economics Institute*, Working Paper Series, No. 515. http://dx.doi.org/10.2139/ssrn.1014163

Charts and tables

Tab. 1. Key to symbols, coefficient values and initial values of variables

Symbol	Description	Type	Value
α_1	Propensity to consume out of income	En	0.75
α_{10}	Autonomous component of propensity to consume	X	0.75
α_{11}	Sensitivity of propensity to consume to interest rate	X	1.00
α_{12}	Sensitivity of propensity to consume to unemployment rate	X	0.05
α_2	Propensity to consume out of cash	X	0.15
α_3	Propensity to consume out of cheque deposits	X	0.10
α_4	Propensity to consume out of saving deposits	X	0.05
α_5	Propensity to consume out of government bills	X	0.01
α_6	Propensity to consume out of shares and other firms' securities	X	0.01
α_g	Share of public to total goods consumed by households	X	0.015
β	Share of notional bills held as bills by banks	X	0.50
χ	Target percentage of investment to be funded by share issues	En	0.001
δ	Depreciation rate of capital	X	0.10
δ_g	Speed of adjustment of JG programme to market conditions	X	0.20
γ	Reaction speed of adjustment of capital to its target value	X	0.15
γ_1	Autonomous coefficient of Minsky investment function	X	2.00
γ_2	Sensitivity of Minsky investment to Tobin q	X	2.00
κ	Capital-Output ratio	X	1.00
λ_{10}	Parameter in portfolio equation of bills	X	0.15
λ_{11}	Parameter in portfolio equation of bills	X	0.20
λ_{12}	Parameter in portfolio equation of bills	X	-0.10
λ_{13}	Parameter in portfolio equation of bills	X	-0.10
λ_{14}	Parameter in portfolio equation of bills	X	0
λ_{20}	Parameter in portfolio equation of cheque deposits	X	0.20
λ_{21}	Parameter in portfolio equation of cheque deposits	X	-0.10
λ_{22}	Parameter in portfolio equation of cheque deposits	X	-0.10
λ_{23}	Parameter in portfolio equation of cheque deposits	X	0.20
λ_{24}	Parameter in portfolio equation of cheque deposits	X	0
λ_{30}	Parameter in portfolio equation of firms' securities	X	0.10
λ_{31}	Parameter in portfolio equation of firms' securities	X	-0.10
λ_{32}	Parameter in portfolio equation of firms' securities	X	0
λ_{33}	Parameter in portfolio equation of firms' securities	X	0
λ_{34}	Parameter in portfolio equation of firms' securities	X	0
λ_{40}	Parameter in portfolio equation of cash	X	0.04
λ_{41}	Parameter in portfolio equation of cash	X	0
λ_{42}	Parameter in portfolio equation of cash	X	0
λ_{43}	Parameter in portfolio equation of cash	X	0.05
λ_{44}	Parameter in portfolio equation of cash	X	0
λ_c	Cash to consumption ratio	X	0.18
μa	Mark-up of return rate on CB advances	X	0.005
μb	Mark-up for return rate on bills	En	0.01
μb_0	Coefficient of return rate on bills	X	0.01
μb_1	Coefficient of return rate on bills	X	0.0025
μh	Mark-up of return rate on reserves	X	0
μl	Mark-up of interest rate on loans	En	0.02
μl_0	Coefficient of interest rate on loans	X	0.02
μl_1	Coefficient of interest rate on loans	X	0.01
μlh	Mark-up of interest rate on mortgages	X	0.02
μm	Mark-up of return rate on saving deposits	X	0.01
μp	Mark-up over labour cost	X	0.163
ν	Speed of adjustment of labour supply to labour demand	X	0.20
Ω	Wage share to total income	En	0
ω_0	Speed of adjustment of un to nun	X	0.01
ϕ	Mortgages to disposable income ratio	X	0.03
ψ_1	Coefficient of price expectations function	X	0
ψ_2	Coefficient of price expectations function	X	0.01

ρ_g	Ratio of government wage rate to private sector wage rate	X	0.75
ρ_1	Reserves to cheque deposits parameter	X	0.025
ρ_2	Reserves to saving deposits parameter	X	0.005
σ_0	Autonomous component of government spending	X	5.00
σ_1	Dependent component of government spending	X	0.15
τ_0	Autonomous component of tax revenues	X	0
τ_1	Tax rate on labour incomes	X	0.20
τ_2	Tax rate on capital incomes	X	0.20
τ_3	Tax rate on wealth	X	0.005
τ_4	Other transfers	X	2.00
τ_5	Unemployment benefits (relative to unemployment rate)	X	5.00
θ	Profit retention rate	X	0.02
ε	Target share of bills held by CB	En	0
ε_0	Autonomous component of target share of bills held by CB	X	0
ε_1	Sensitivity of target share of bills to interest rate	X	0
ad	Demand for advances	En	0
af	Amortization funds	En	0
as	Supply of advances from CB	En	0
bb	Bills held by commercial banks	En	0
bb_{not}	Notional amount of bills held by banks	En	0
bcb	CB holdings of bills	En	0
bh	Household holdings of bills	En	0
bpr	Share of bills purchased by private sector	En	1.00
bs	Bills issued by the Treasury	En	0
c	Demand for consumption goods by households	En	0
cg	Capital gains on firms' shares	En	0
da	Depreciation allowances	En	0
def	Government deficit	En	0
eh	Firms' equity, shares and securities held by households	En	0
ep	Expected price level	En	1.00
esr	Number of securities issued by firms	En	0
fb	Bank profits	En	0
fcb	Central bank profit	En	0
fdf	Distributed profits of firms (dividends)	En	0
ff	Profits of firms	En	0
fuf	Undistributed profits of firms (retained profits)	En	0
gl	Structural rate of growth of labour force	X	0.03
gov	Government spending	En	0
gov_h	Autonomous government spending funded by cash only	En	0
hbd	Reserve requirement: demand	En	0
hbd^*	Extra reserves demanded by banks	En	0
hbs	Reserve requirement: supply	En	0
hbs^*	Extra reserves supplied by the CB	En	0
her	Number of securities held by households	En	0
hg	Overt monetary financed debt	En	0
hh	Household holdings of cash	En	0
hs	Supply of cash	En	0
Id	Investment	En	0
jg	Job guarantee spending	En	0
[ρ_{jg}	Job guarantee spending to GDP ratio	X	0.03
k	Stock of capital	En	0
kt	Target stock of capital	En	0
lev	Leverage ratio of firms	En	1.00
lf	Demand for bank loans	En	0
lh	Mortgages to households	En	0
ls	Supply of bank loans	En	0
$m1h$	Cheque deposits held by households	En	0
$m1s$	Supply of cheque deposits	En	0
$m2h$	Saving deposits held by households	En	0
$m2s$	Supply of saving deposits	En	0
nd	Labour demand	En	0
ng	People hired by the government (under job guarantee)	En	0
ns	Labour supply	En	0

nun	Non-inflationary rate of unemployment	X	0
nvh	Household net wealth	En	0
p	General price level	En	1.00
pf	Unit price of private output	En	1.00
pg	Unit price of government output	En	1.00
pe	Unit price of firms' securities	En	1.00
π	Inflation rate	En	0
π^T	Target or normal inflation rate	X	0
prf	Product per worker in private sector	X	1.00
prg	Product per worker in government sector	X	0.75
q	Valuation ratio (Tobin q)	En	0.80
r^*	Policy rate	X	0.02
ra	Rate of interests on CB advances	En	0.025
rb	Return rate on bills	En	0.03
re	Return rate on firms' securities	En	0.02
rep	Repayment rate on mortgages	X	0.01
rh	Rate of interest on reserves	En	0.02
rl	Rate of interest on banks loans	En	0.04
rlh	Interest rate on mortgages	En	0.04
rm	Rate of interest on saving deposits	En	0.03
tax	Total tax revenue	En	0
tr	Total transfers	En	0
un	Unemployment rate	En	0
vh	Household wealth	En	0
w	Money wage rate paid by the firms	En	0.86
wb	Wage bill	En	0
wg	Wage rate paid by the government	En	0.645
y	Total income	En	40.00
yd	Disposal income of households	En	0

Note: En = endogenous variables; X = exogenous variables and parameters

Fig. 2. Baseline: consistency check and selected variables

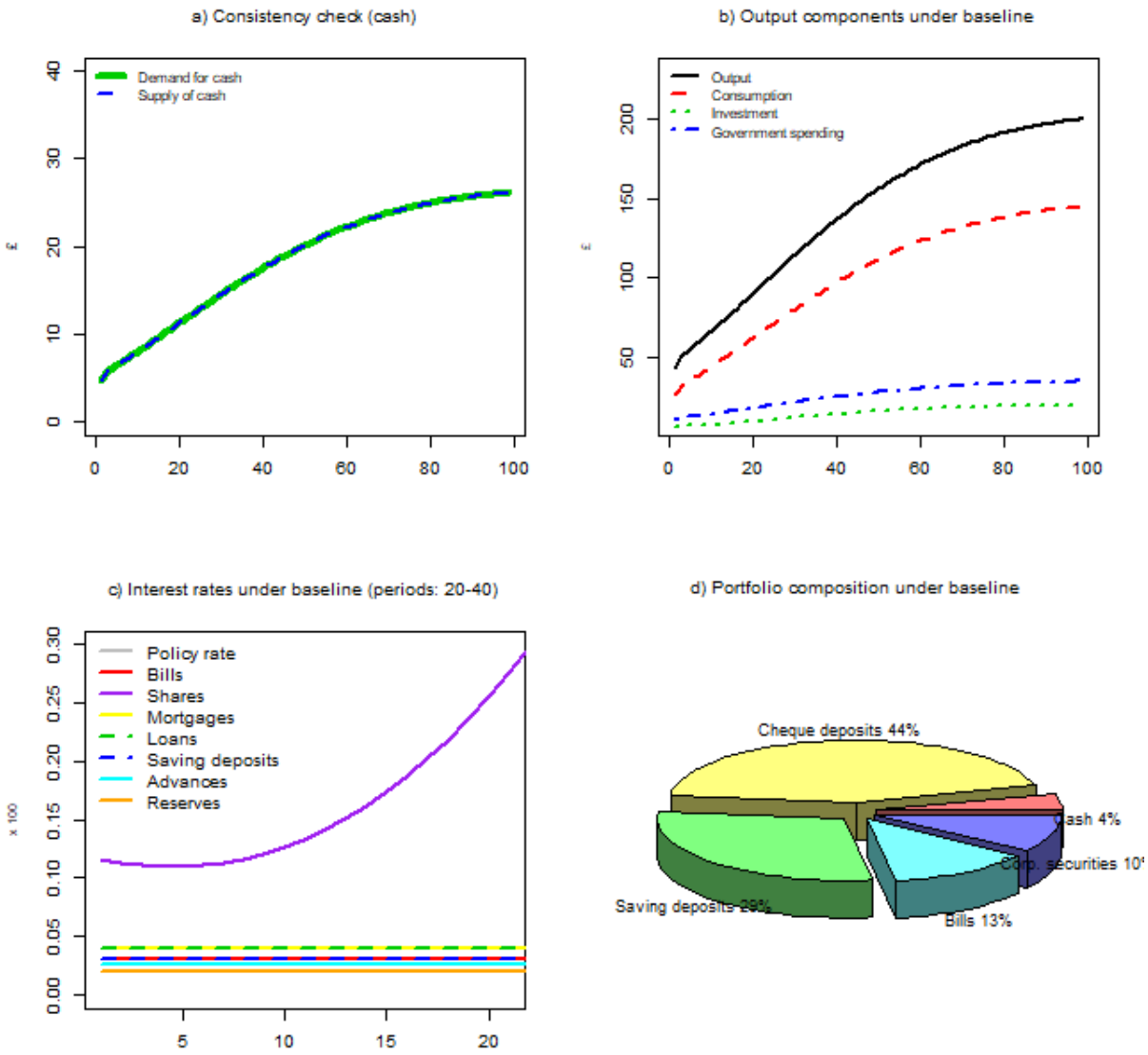


Fig. 3. Impact of selected policies using standard investment function (values relative to baseline)

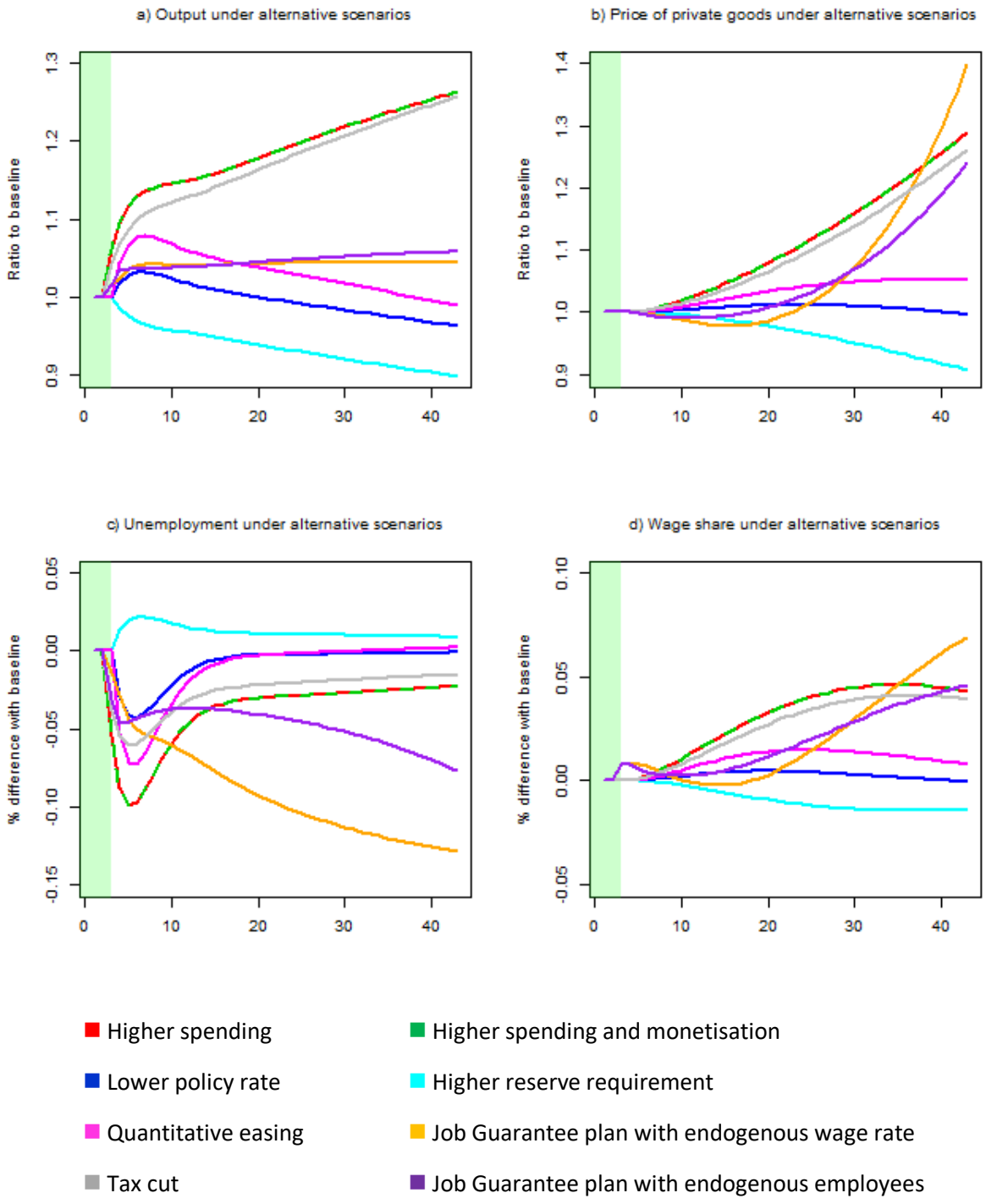


Fig. 3. Cont'd

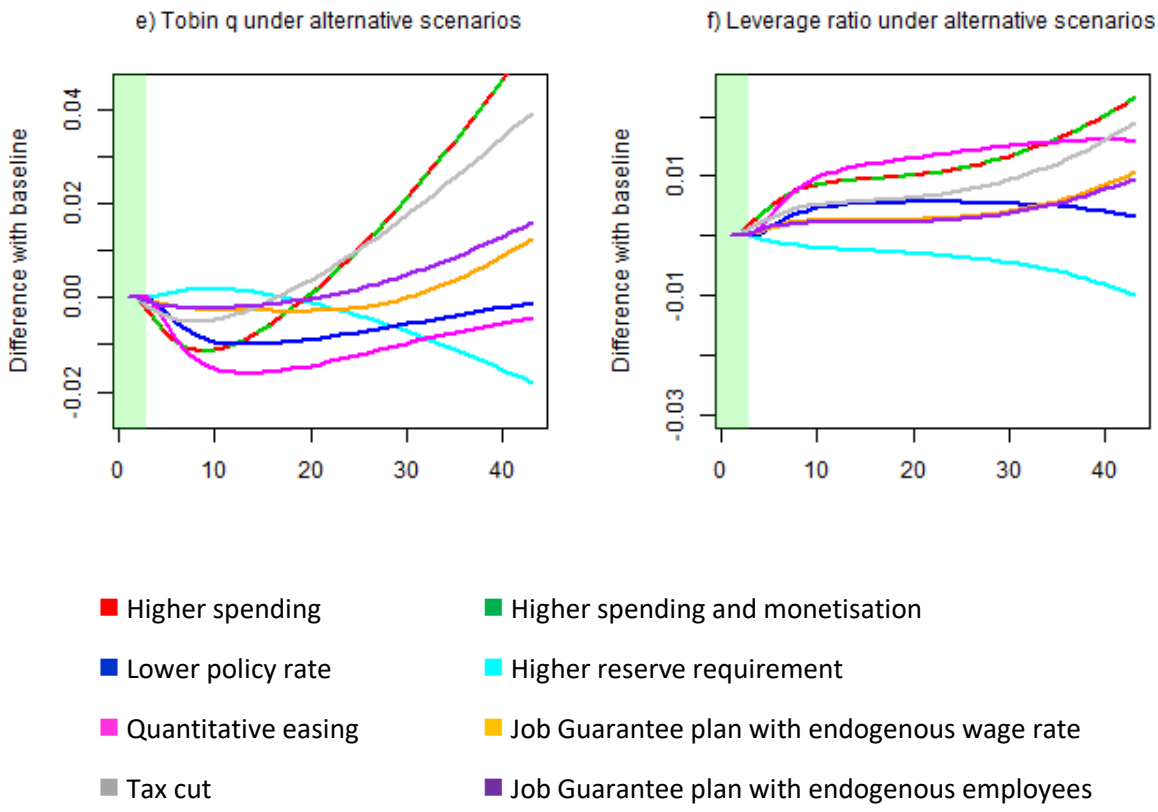

e) Tobin q under alternative scenarios
Difference with baseline
-0.02
0.00
0.02
0.04
0
10
20
30
40
f) Leverage ratio under alternative scenarios
Difference with baseline
-0.03
-0.01
0.01
0
10
20
30
40
Higher spending
Higher spending and monetisation
Lower policy rate
Higher reserve requirement
Quantitative easing
Job Guarantee plan with endogenous wage rate
Tax cut
Job Guarantee plan with endogenous employees

Fig. 4. Impact of selected policies using Minsky-like investment function (values relative to baseline)

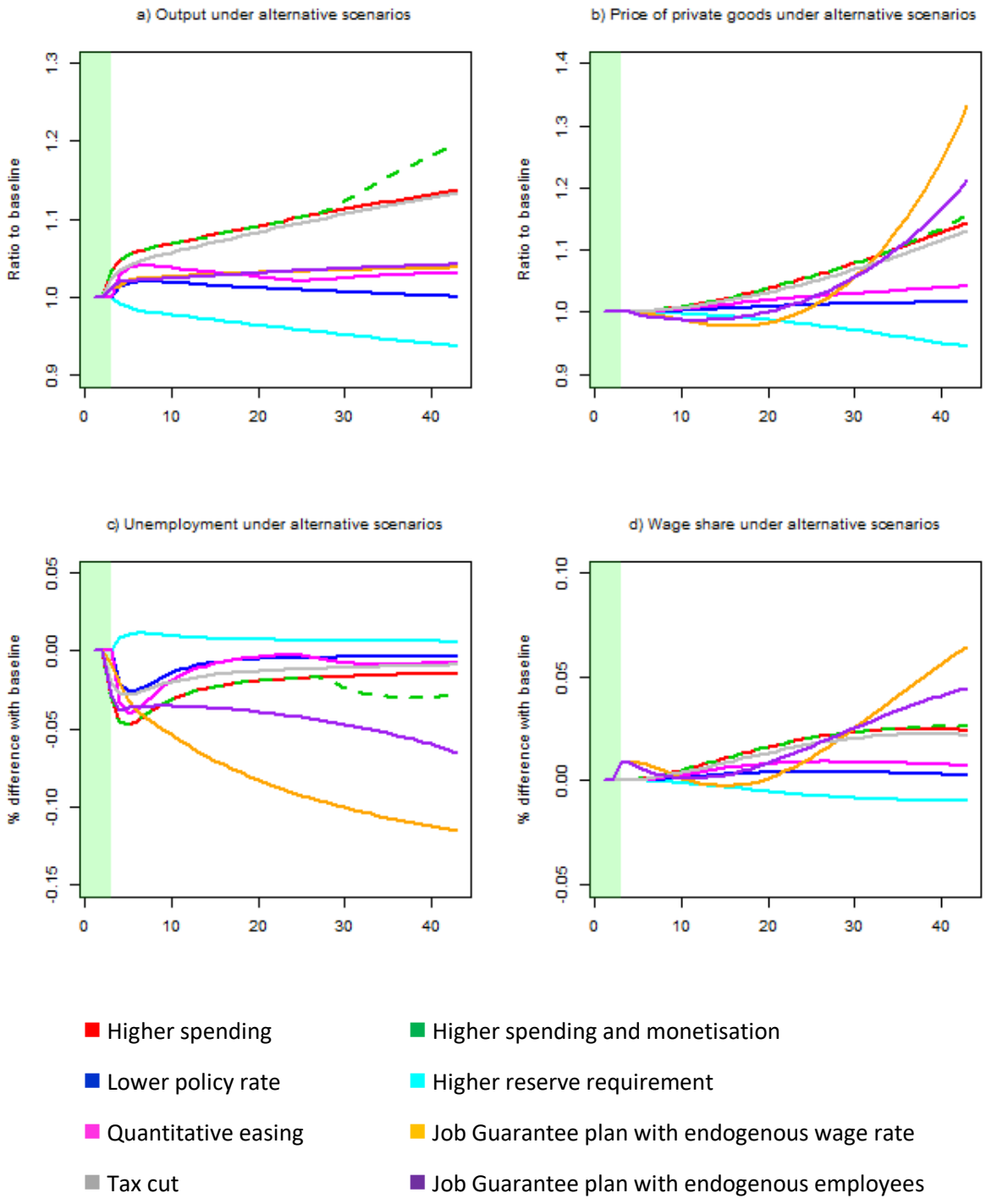


Fig. 4. Cont'd

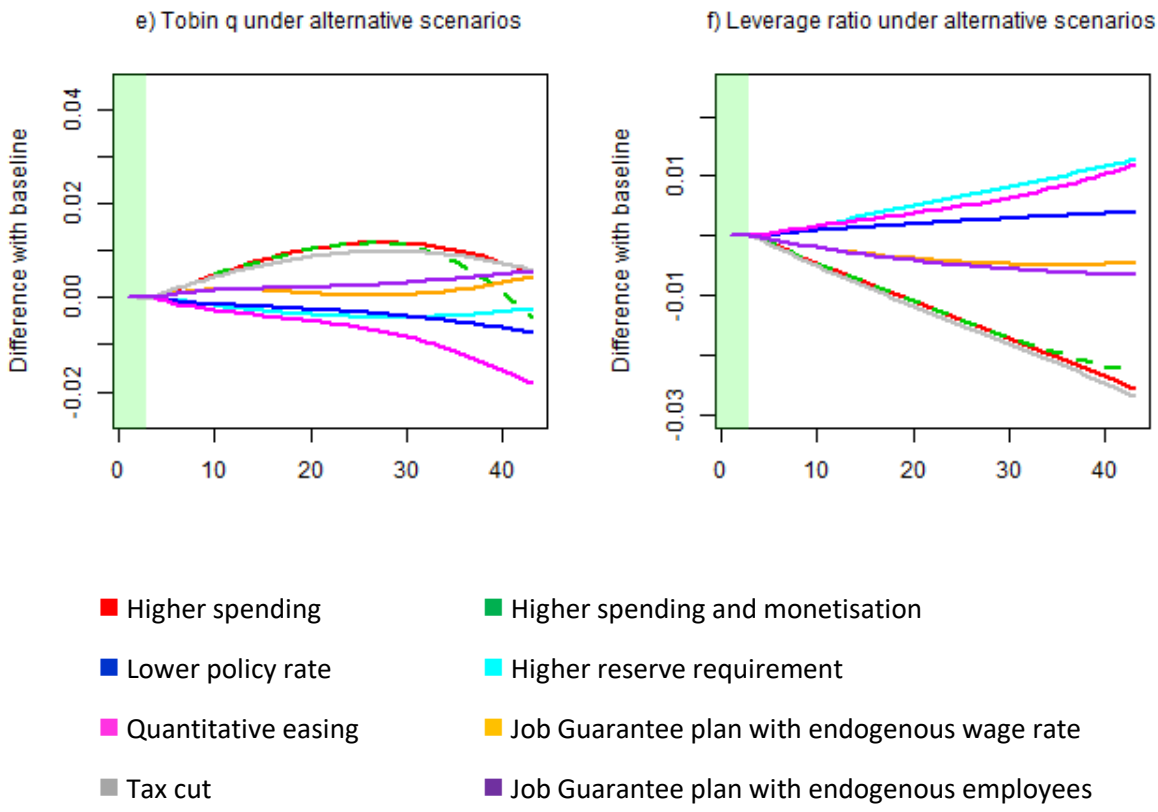

e) Tobin q under alternative scenarios
Difference with baseline
0.04
0.02
0.00
-0.02
0
10
20
30
40
f) Leverage ratio under alternative scenarios
Difference with baseline
0.01
-0.01
-0.03
0
10
20
30
40
Higher spending
Higher spending and monetisation
Lower policy rate
Higher reserve requirement
Quantitative easing
Job Guarantee plan with endogenous wage rate
Tax cut
Job Guarantee plan with endogenous employees

Fig. 5. Impact of Job Guarantee vs. convention spending using standard investment function

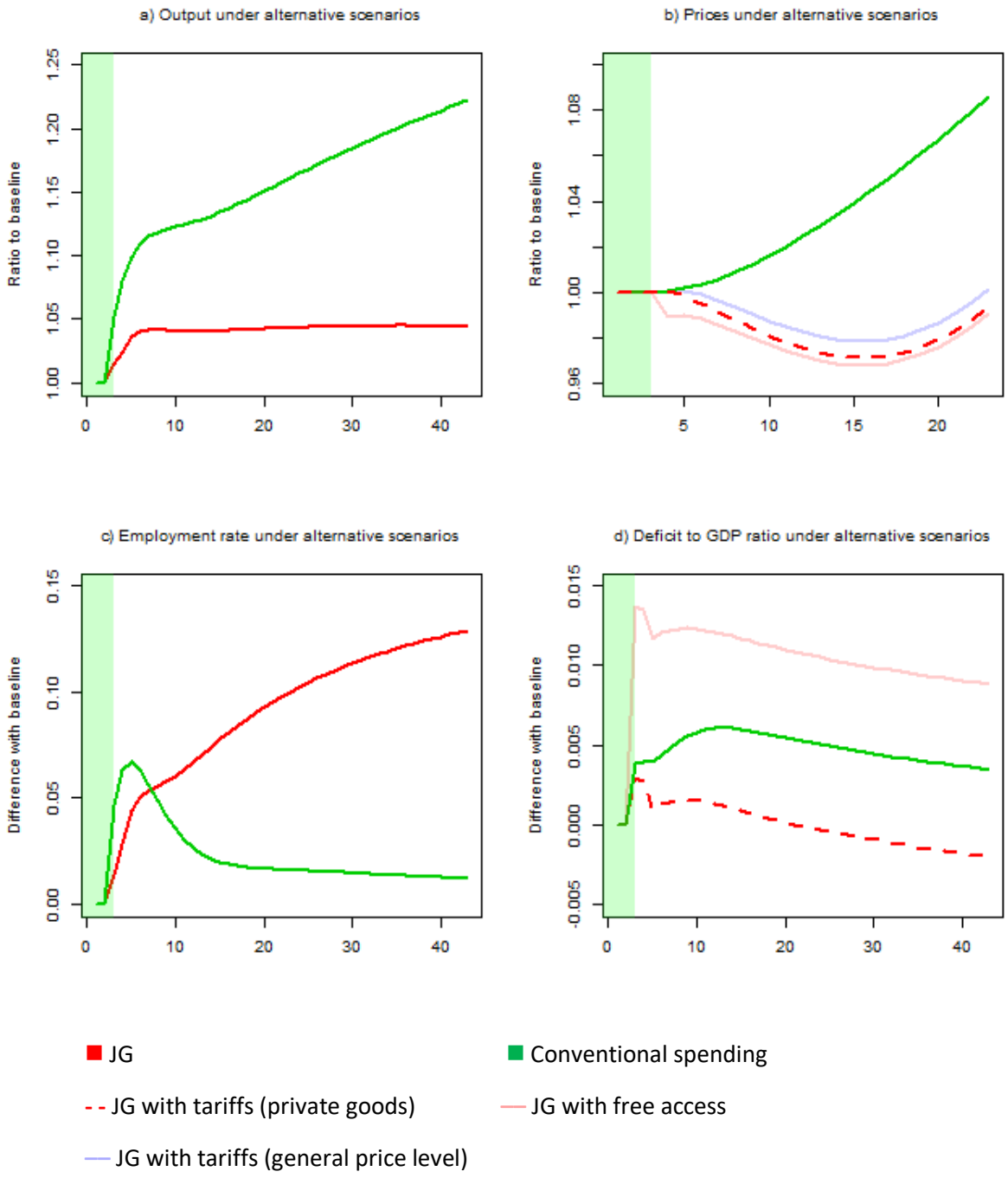


Fig. 6. Impact of Job Guarantee vs. convention spending using Minsky-like investment function