News and Business Cycles in Open Economies*

Nir Jaimovich† and Sergio Rebelo‡

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Abstract

We study the effects of news about future total factor productivity (TFP) in a small-open economy. We show that an open-economy version of the neoclassical model produces a recession in response to good news about future TFP. We propose an open-economy model that generates comovement in response to TFP news. The key elements of our model are a weak short-run wealth effect on the labor supply and adjustment costs to labor and investment. We show that our model also generates comovement in response to news about future investment-specific technical change and to 'sudden stops.'

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†Stanford University and NBER.
‡Northwestern University, NBER, and CEPR.

1. Introduction

A key property of business cycle data is the presence of strong comovement among the major macroeconomic variables. Output, consumption, investment, and hours worked are highly correlated at business cycle frequencies. Comovement among these variables arises naturally in versions of the neoclassical model that are driven by contemporaneous shocks to productivity (Kydland and Prescott (1982), Barro and King (1984)). In contrast, the neoclassical model fails to generate comovement in response to news about future total factor productivity (TFP).[1] Good news about future TFP has a positive wealth effect that leads to a rise in consumption and leisure. Hours worked fall, so output declines. Since consumption rises and output falls, investment also falls.[2]

There is a literature that studies the effects of news shocks in closed economies.[3] But, to our knowledge, the effects of news shocks have not been studied in an open-economy setting. In this paper we take a first step in this direction by studying the response of a small-open economy that can borrow and lend in international capital markets to news about the future. We find that an open-economy version of the neoclassical model fails to generate comovement in response to news about future TFP. As in the closed economy neoclassical model, the wealth effect of news on the labor supply is at the root of this failure. Good news about the future generates a positive wealth effect that induces a decline in hours worked.

We propose a small-open economy model that generates comovement in response to news about future TFP. The key elements of this model are a weak

[1]See Beaudry and Portier (2004, 2005).

[2]For high levels of intertemporal substitution in consumption it is possible for consumption to fall and investment to rise in response to positive news about future productivity. There is also no comovement in this case.

[3]See, for example, Beaudry and Portier (2004, 2005), Christiano, Motto and Rostagno (2005), Denhaan and Kaltenbrunner (2005), Lorenzoni (2005), Jaimovich and Rebelo (2006), and Beaudry, Collard, and Portier (2007).

short-run wealth effect on labor and adjustment costs to labor or investment.

To assess the robustness of the comovement properties of our model we consider two additional shocks: news about investment-specific technical change and sudden stops. Sudden stops are shocks to open economies that increase the cost of rolling over their existing foreign debt. Calvo (1998) emphasizes that this type of shock is associated with falls in consumption, investment, and output. However, in open-economy versions of the neoclassical-growth model, sudden stops generate a boom in output.[4] This boom results from the sudden stop's negative wealth effect which leads agents to reduce leisure and increase the number of hours worked.

We organize the paper as follows. In Section 2 we present a small-open-economy version of the neoclassical model and discuss the effects of news about future TFP. In Section 3 we introduce our benchmark model and use it to study the effects of news about future TFP, news about investment-specific shocks, and sudden stops. In Section 4 we discuss the robustness of our results to different model parameterizations. We provide concluding remarks in Section 5.

2. News in a small-open-economy

This economy is populated by identical agents who maximize their lifetime utility (U) defined over sequences of consumption (C_t) and hours worked (N_t):

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma}\left(1-\psi N_t^{\theta}\right)^{1-\sigma}-1}{1-\sigma}.$$

The symbol E_0 denotes the expectation conditional on the information available at time zero. We assume that $0<\beta<1$, $\theta>1$, $\psi>0$ and $\sigma>0$. Output (Y_t) is

[4] See Chari, Kehoe and McGratten (2005) and Kehoe and Ruhl (2007).

produced with a Cobb-Douglas production function using capital (K_t) and labor:

$$Y_t = A_t K_t^{1-\alpha}(N_t)^{\alpha}. \tag{2.1}$$

The variable A_t represents the exogenous level of TFP. The law of motion for capital is given by:

$$K_{t+1} = I_t + (1-\delta)K_t. \tag{2.2}$$

The economy can borrow and lend at a real interest rate r_t, subject to the flow budget constraint:

$$a_{t+1} = (1+r_t)a_t + Y_t - C_t - I_t/z_t, \tag{2.3}$$

and to the non-Ponzi game restriction:

$$E_0 \lim_{t\to\infty} \frac{a_{t+1}}{\Pi_{i=1}^{t}(1+r_t)} = 0. \tag{2.4}$$

The variable a_t represents the economy's net foreign assets. The variable $1/z_t$ represents the current state of technology to produce capital goods. We interpret increases in z_t as resulting from investment-specific technical progress as in Greenwood, Hercowitz, and Krusell (2000).

The economy's trade balance, TB_t, is given by:

$$TB_t = Y_t - C_t - I_t/z_t.$$

In the model described so far the steady-state level of a_t is not unique. This property can be a problem for the accuracy of linearizations around the steady state, since we linearize the model around a steady state value of a_t to which the economy does not return. One simple, albeit mechanical, solution to this problem is to assume that the real interest rate faced by the economy is a decreasing function of the level of net foreign assets. We assume that this function takes the form:

$$r_t = 1/\beta - 1 + \chi[\exp(a^* A_t^{1/\alpha} z_t^{(1-\alpha)/\alpha} - a_t) - 1], \tag{2.5}$$

where $\chi > 0$.[5] It is easy to show that, when the real interest rate is governed by (2.5), the steady state value r_t is $1/\beta - 1$. We assume that a^* is negative. In the steady state the country is indebted vis-a-vis the rest of the world and runs a trade surplus to service this debt. The steady state level of output is proportional to $A_t^{1/\alpha} z_t^{(1-\alpha)/\alpha}$, so the economy's ability to borrow is scaled by trend GDP.

We solve the model numerically by log-linearizing the first-order conditions of the planner's problem around the steady state. Each period is assumed to represent one quarter. We calibrate the model with the following parameters. We set the discount factor, β, to 0.985. We set the labor share, α, to 0.64, the depreciation rate, δ, to 0.0125, the coefficient of relative risk aversion, σ, to 1, and θ, the parameter that controls the elasticity of labor supply, to 1.2. We choose the level parameter in the utility function, ψ, so that $N = 0.2$ in the steady state. We set $\chi = 0.00001$ and choose the value of a^* so that the steady-state value of TB/Y is four percent.

Unless we indicate otherwise, all variables included in the impulse response functions that we report are expressed as percentage deviations from their steady state values.

News about future TFP The dotted line in Figure 1 shows the neoclassical model's response to unanticipated news about future TFP. The timing is as follows. The economy is in the steady state at time zero. At time one agents receive unanticipated news that TPF will increase permanently by one percent from period three on. The positive news shock raises agent's wealth leading to

[5] This formulation is a modified version of the one proposed by Uribe and Schmidt-Grohe (2003), where the real interest rate in given by: $r_t = 1/\beta - 1 + \chi[\exp(a^* - a_t) - 1]$. An advantage of our formulation is that it makes hours worked and the ratio of foreign debt to GDP stationary. In small-open-economy models hours worked tend to be non-stationary even when preferences take the form discussed in King, Plosser, and Rebelo (1988) (see Correia, Neves, and Rebelo (1995)).

a rise in consumption and leisure, and a decline in hours worked. The decline in hours produces a decline in output. Investment falls in period one and rises in period two. The fall in period one occurs in response to the fall in the marginal product of capital that results from the decline in hours worked. The investment rise in period two occurs in anticipation of the TFP shock that materializes in period three. The economy's trade balance is dominated by these large investment swings. The economy runs a large trade surplus in period one and a large trade deficit in period two. In summary, the economy does not exhibit comovement in response to news about future TFP. Good news about future TFP produce a current fall in output.

It is useful to compare the response to unanticipated news about future TFP in the open and a closed economy version of the neoclassical model. This comparison is shown in Figure 2. The solid line represents the response of the closed economy, while the dashed line represents the response of the open economy. In the closed economy the real interest rate rises, reflecting the high future marginal product of capital. This persistent rise in the real interest rate has two implications. The first implication is that consumption grows over time in the closed economy. In contrast, in the open economy consumption rises at time one and remains roughly constant thereafter, reflecting the fact that real-interest-rate movements are very small. The second implication is that hours fall by more in the open economy, producing a larger decline in output. In the closed economy the high real interest rate in period two creates an intertemporal substitution effect on the supply of labor which helps to partially offset the wealth effect. This intertemporal substitution effect is absent in the open economy.

In the closed economy consumption rises and output falls so investment falls in periods one and two. In the open economy investment falls in period one and rises in period two. The fall in period one occurs in response to the fall in the marginal product of capital that results from the decline in hours worked. The investment rise in period two occurs in anticipation of the TFP shock that materializes in period three. The economy's trade balance is dominated by these large investment swings. The economy runs a large trade surplus in period one and a large trade deficit in period two. In summary, neither the open nor the closed economy exhibit comovement in response to news about future TFP. In addition, positive news shocks produce a deeper fall in output in the open economy.

3. Our model

We now introduce two new elements into the model of Section 2. The first element is the utility function proposed in Jaimovich and Rebelo (2006). Lifetime utility is given by:

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(C_t - \psi N_t^{\theta} X_t\right)^{1-\sigma} - 1}{1-\sigma}, \tag{3.1}$$

where

$$X_t = C_t^{\gamma} X_{t-1}^{1-\gamma}, \tag{3.2}$$

The presence of the variable X_t implies that preferences are time non-separable in consumption and hours worked. These preferences nest as special cases the two classes of utility functions most widely used in the business cycle literature. When $\gamma = 1$ we obtain preferences in the class consistent with steady state growth discussed in King, Plosser and Rebelo (1988). When $\gamma = 0$ we obtain the preferences proposed by Greenwood, Hercowitz, and Huffman (1988), which feature zero wealth effects on the supply of labor but are not consistent with steady state growth. The preferences described by (3.1) and (3.2) are consistent with steady state growth as long as $0 < \gamma \leq 1$. These preferences allow us to parameterize the strength of the wealth effect through the choice of γ. The lower the value of γ

the weaker are short-run wealth effects on the supply of labor (see Jaimovich an Rebelo (2006)).

The second element that we introduce are adjustment costs to both investment and labor. We replace equation (2.2) with the following capital accumulation equation,

$$K_{t+1} = I_t \left[1 - \phi \left(\frac{I_t}{I_{t-1}} \right) \right] + (1 - \delta) K_t. \tag{3.3}$$

The function $\phi(.)$ represents adjustment costs to investment. We assume that $\phi(1) = 0$, $\phi'(1) = 0$, and $\phi''(1) > 0$. These conditions imply that there are no adjustment costs in the steady state and that adjustment costs are incurred when the level of investment changes over time. This adjustment cost formulation is proposed in Christiano, Eichenbaum and Evans (2004) and in Christiano, Motto and Rostagno (2005).[6]

We also introduce labor adjustment costs, along the lines emphasized by Sargent (1978), in the economy's flow resource constraint. We replace equation (2.3) with:

$$a_{t+1} = (1 + r_t) a_t + Y_t - C_t - I_t / z_t - N_t \Psi \left(\frac{N_t}{N_{t-1}} \right).$$

We assume the following properties for the labor adjustment cost function: $\Psi(1) = 0$, $\Psi'(1) = 0$, and $\Psi''(1) > 0$.

The trade balance is defined as:

$$TB_t = Y_t - C_t - I_t / z_t - N_t \Psi \left(\frac{N_t}{N_{t-1}} \right).$$

In our numerical experiments we set $\phi''(1) = 1.3$, $\Psi''(1) = 2.0$, and $\gamma = 0.0001$. In Section 4 we explore the robustness of our findings to different parameter values.

[6] Lucca (2007) shows that, for an appropriate choice of the parameter values, the linearized investment first-order condition is identical when adjustment costs take the form (3.3) and when there is time-to-build in investment.

News about future TFP The solid line in Figure 1 shows the response of our model to news of a permanent, one percent increase in the level of TFP in period three. This news generates a boom in periods one and two. The rise in consumption, investment, and output is accompanied by a deterioration of the trade balance. The intuition for why a boom takes place is as follows. The very low value of γ used in our calibration ($\gamma = 0.0001$) implies that the short-run wealth effect on the labor supply is very small. Hours should fall by a small amount, so why do they rise in period one? This rise reflects the presence of adjustment costs to labor. It is optimal to increase N_t in period three to respond to the increase in TFP. Labor adjustment costs make it efficient to start raising N_t at time one.[7] Similarly, adjustment costs to investment make it efficient to start investing in period one, instead of waiting for period two.

To understand better the role of the different model elements in generating comovement, we show in Figure 3 the response of four versions of our model to news about future TFP. The timing of the news shock is the same as in Figure 1. The first model is the benchmark model, which we just described. The second model is a version of the benchmark model where preferences take the form discussed in King, Plosser, and Rebelo (1988) ($\gamma = 1$). We can see that with these preferences hours worked fall. News of higher future values of A_t create a positive wealth effect that induces the agent to increase its leisure, reducing the number of hours worked. The fall in hours creates a fall in output. The third model is a version of our benchmark model without investment adjustment costs. This model still exhibits comovement but investment is too volatile. Finally, the fourth model is a version of our benchmark model without labor adjustment costs. In this version

[7] Hours worked return slowly to the steady state after the shock. This slow adjustment results from the low values of γ (see Jaimovich and Rebelo (2006) for a discussion), and also from the low value of χ which implies that movements in the real interest rate faced by the economy are very small.

of the model labor fall slightly when news arrives. The reason for this fall is that $\gamma = 0.0001$, so there is still some wealth effect on the labor supply. In summary, low values of γ and adjustment costs to labor are important to produce a rise in hours in response to news about future TFP. Investment adjustment costs are important to generate realistic investment volatility.

News about future z Figure 4 shows the response of our model to news about future values of z_t. At time one the economy receives unanticipated news that there is a permanent, one percent increase in the level of investment-specific technical progress, z_t. We see that the same mechanisms that generate comovement in response to news about TFP also generate comovement in response to news about z_t. Increases in consumption, investment, and output are accompanied by a deterioration of the trade balance. Adjustment costs to labor generate an increase in hours worked in period one and two, just like in the response to a TFP shock.

Adjustment costs to investment are essential to produce a rise in investment in response to news about future rises in z. This news implies that investment is cheaper in the future, so it is optimal to reduce investment today and increase it in the future. Adjustment costs to investment provide an incentive to smooth investment over time, so investment starts increasing in period one, in anticipation of further rises in period three.

Sudden stops A sudden stop is an increase in the cost of rolling over a country's existing foreign debt. In open economy versions of the neoclassical model, such as the ones considered in Chari, Kehoe and McGratten (2005) and Kehoe and Ruhl (2007), a sudden stop produces an expansion. This expansion arises because the sudden stop generates a negative wealth effect that leads to a fall in leisure and to an expansion in hours worked. The prediction that sudden stops are associated with expansions is counterfactual. Sudden stop episodes, such as those discussed by Calvo, Izquierdo, and Mejia (2004) and Bordo, Cavallo, and Meissner (2007) are associated with recessions.

To study the effect of a sudden stop we set $\chi = 0.25$, so the economy can reduce substantially the cost of servicing its foreign debt by increasing the level of net foreign assets. We assume that a^* is stochastic and follows an AR(1) process with first-order serial correlation equal to 0.9. We model a sudden stop as an increase in a^*.[8]

Figure 5 shows an impulse response function to a one-percent increase in a^*. The persistent increase in a^* that starts at time one raises the cost of borrowing. The quarterly real interest rate rises from 1.5 percent to 2.2 percent in period one. The rise in borrowing costs is associated with a large increase in the time-one trade surplus and to a fall in investment. This fall leads to a temporary reduction in the stock of capital, which causes a temporary fall in the future marginal product of labor. The temporary fall in the marginal product of labor leads to a future reduction in hours worked. In the presence of labor adjustment costs, it is optimal to smooth the reduction in N_t over time, so labor starts falling in period one.

One desirable property of our model is that it also generates a recession when sudden stops are anticipated.[9] A future sudden stop generates future declines in investment and hours worked. In the presence of adjustment costs labor and investment fall today in anticipation of the future declines in these variables.

[8] This formulation is different from that in Chari, Kehoe and McGratten (2005) and Kehoe and Ruhl (2007). These papers model sudden stops as a reduction in the country's ability to borrow, that forces it to increase the level of a_t.

[9] A number of authors have suggested that a sudden stop can be accompanied by a fall in output when financing frictions are introduced at the level of the firm. Neumeyer and Perri (2004), assume that firms must borrow to pay for a fraction of the wage bill, while Christiano, Gust, and Roldos (2004) and Mendoza (2004), assume that firms must borrow to pay for imported intermediate inputs. These formulations generate a recession in response to an unanticipated sudden stop. However, they tend to generate an expansion if the sudden stop is anticipated.

Consumption also falls upon news of a future sudden stop because of the negative wealth effect associated with the sudden stop.

4. Robustness

We experimented with numerous parameter combinations to assess the robustness of our results. We find that when χ, the elasticity of the real interest rate to net foreign assets, is very small we need a very small value of γ to generate comovement with respect to news shocks and sudden stops. The other parameters are less crucial. We now report some results obtained by changing one parameter at a time relative to our benchmark numerical example.

In the case of news about future TFP we obtain comovement for any value of $\theta \geq 1$ and any value of $\Psi''(1) \geq 0.25$. We can dispense with adjustment costs to investment by setting $\phi''(1) = 0$ or replace the capital law of motion (3.3) with the following, more conventional, formulation:

$$K_{t+1} = \eta(I_t/K_t)K_t + (1-\delta)K_t, \tag{4.1}$$

where $\eta'(.) > 0$ and $\eta''(.) < 0$.

In the case of news about z_t we obtain comovement for any value of $\theta \geq 1$ and for any value of $\Psi''(1) \geq 1.2$. In this case we need some adjustment costs to investment to prevent a fall in investment triggered by the anticipated fall in the price of investment in period 3. Any value of $\phi''(1) \geq 0.05$ is sufficient to generate comovement. We can also replace the adjustment cost formulation (3.3) with the more conventional formulation (4.1).

In the case of sudden stops we obtain comovement for any value of $\theta \geq 1$. We obtain comovement with both (3.3) and (4.1) investment adjustment cost specifications. We can also dispense with investment adjustment costs altogether. In contrast, adjustment costs to labor are indispensable. We need $\Psi''(1) \geq 0.2$.

As we discuss above, without labor adjustment costs hours worked tend to rise in period one by an amount that depends on the magnitude of the negative wealth effect produced by the sudden stop.

In the closed economy model proposed in Jaimovich and Rebelo (2006) variable capital utilization plays a useful role in generating comovement in response to news shocks. We find that capital utilization is not an essential element of our small-open economy model. The intuition for this result is as follows. In the closed economy output needs to rise enough so that both consumption and investment can increase. In the open economy the rise in consumption and investment can be financed by borrowing externally, so the rise in output can be smaller than in the closed economy.

All the results described so far require a value of γ close to zero. However, it is possible to obtain comovement for larger values of γ if we abandon the assumption that χ is close to zero. For larger values of χ we can generate comovement with higher values of γ and, at the same time, obtain plausible real interest rate movements. For example, if we set $\chi = 5$ we can produce comovement with $\gamma = 0.35$.

5. Conclusion

This paper is part of a research program in which we seek to identify model features that generate comovement among the major macroeconomic aggregates in response to different shocks. Here we propose a small-open economy model that generates comovement with respect to news about future TFP and investment-specific technical change. The model also generates comovement in response to 'sudden stop' shocks. We find that the comovement properties of our model are robust, in the sense that they hold for a wide range of parameter values. Comovement is easier to generate in our model in the presence of weak short-run wealth effects on the labor supply, adjustment costs to labor, and/or investment, and whenever the real interest rate faced by the economy rises with the level of net foreign debt.

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Figure 1: Benchmark and neoclassical small-open economy model, response to news about TFP

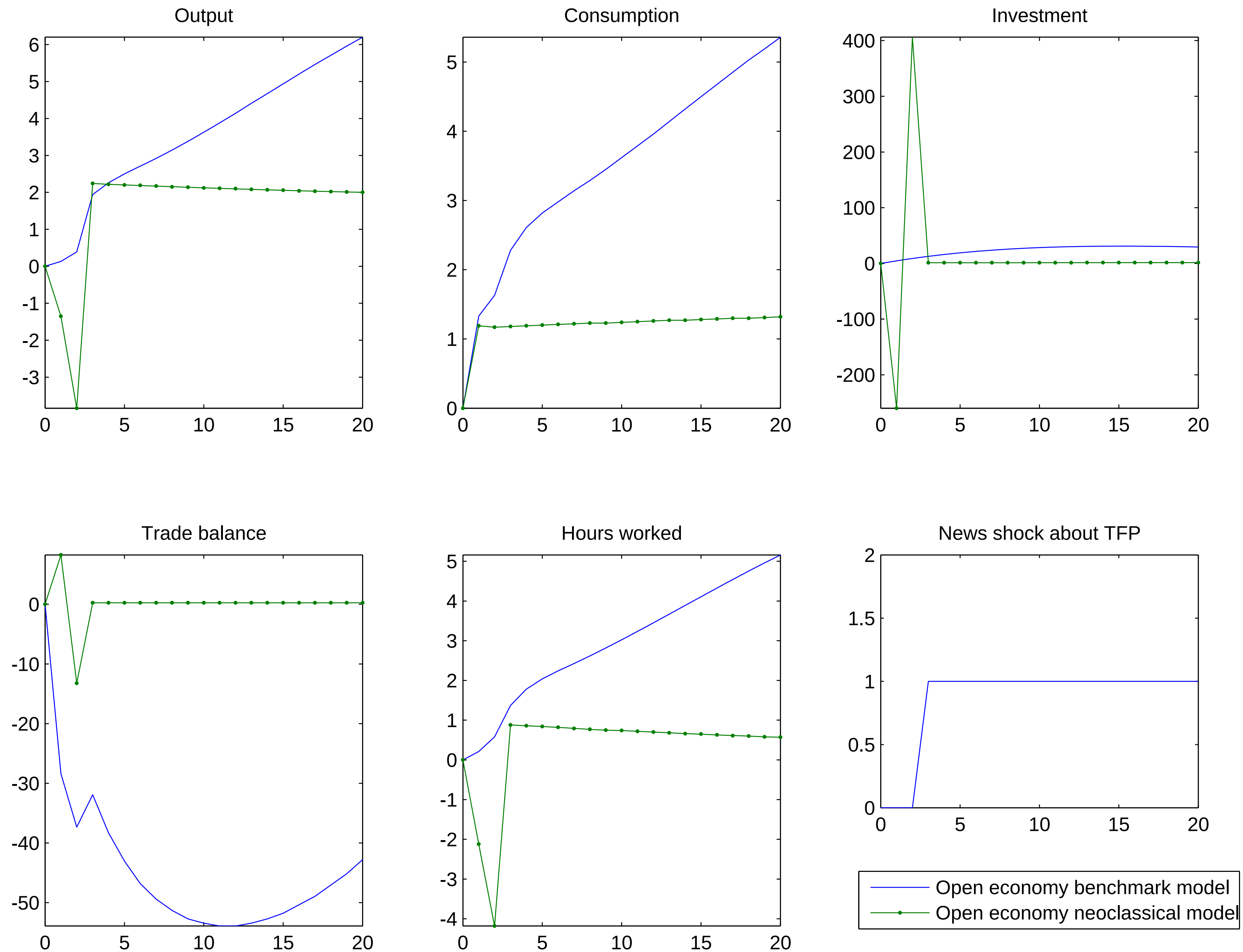

Figure 2: Closed and open economy versions of neoclassical model, response to news about TFP

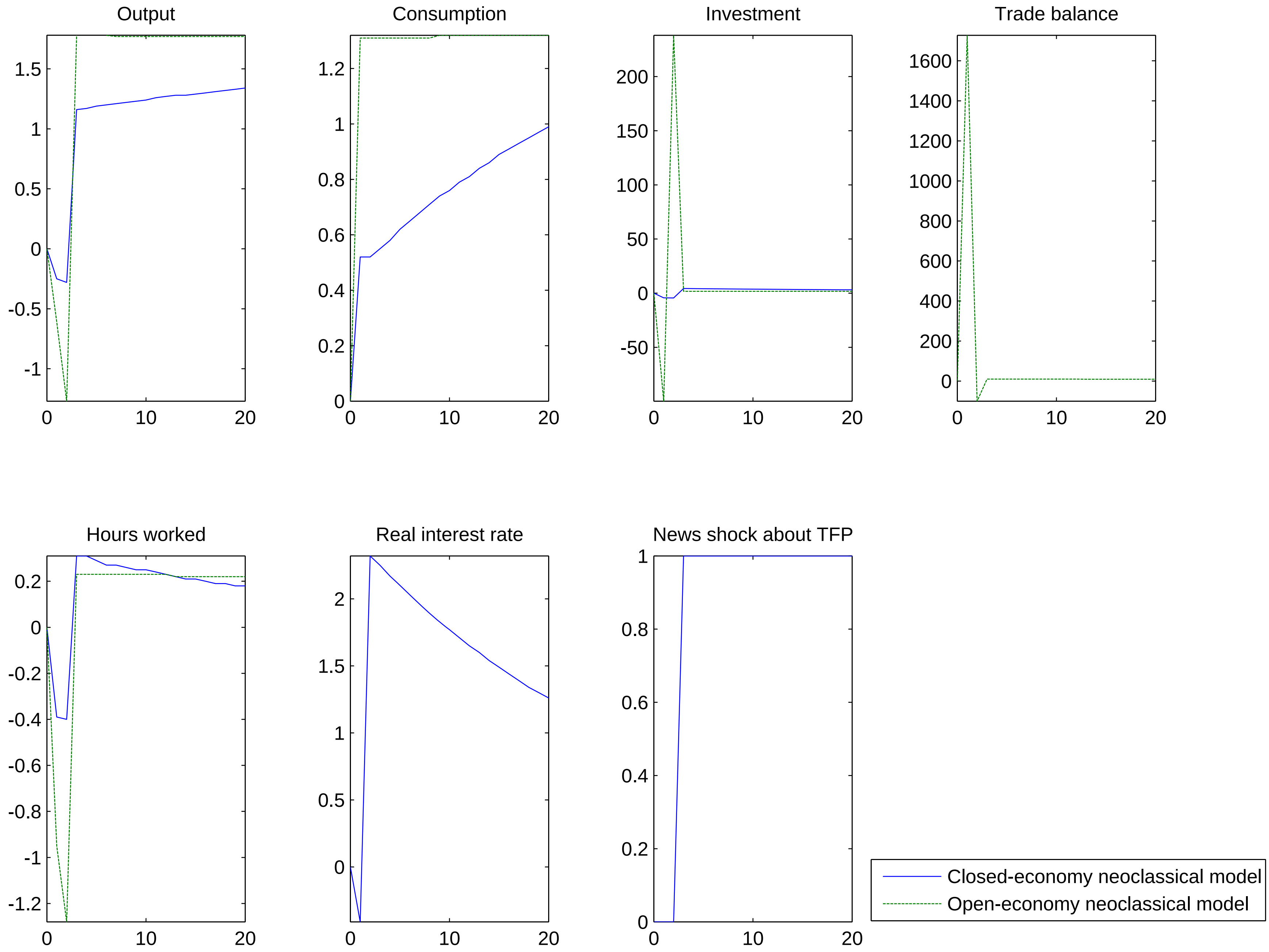

Figure 3: Four versions of open-economy model, response to news about TFP

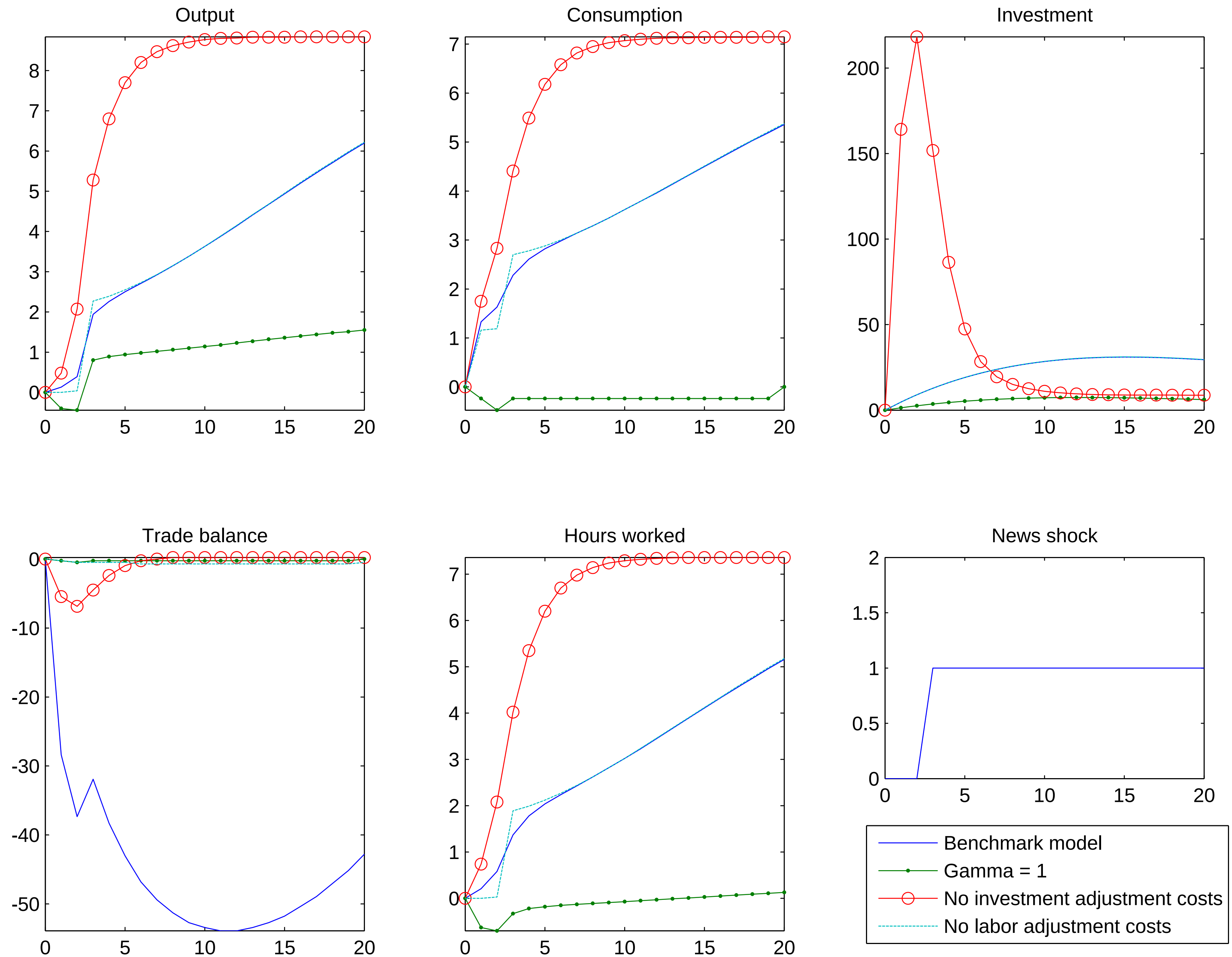

Figure 4: Benchmark small-open economy model, response to news about z

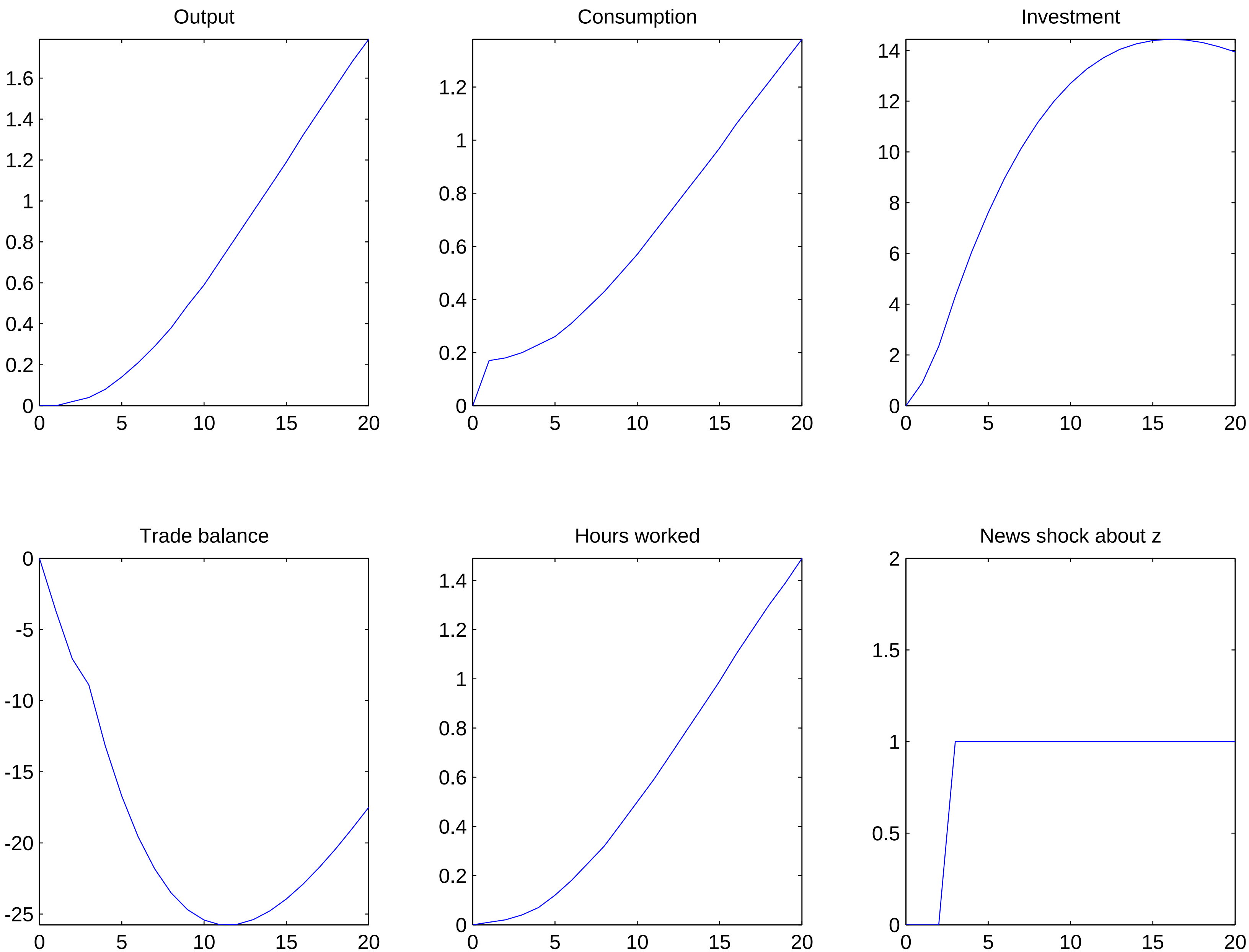

Figure 5: Benchmark small-open economy model, response to sudden stop