Reviving the Salter-Swan Small Open Economy Model*

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Abstract

This paper provides microfoundations to the Salter-Swan policy framework, a graphical apparatus designed to ascertain the exchange-rate and fiscal stance of a policymaker with internal and external economic targets. The environment is an infinite-horizon small open economy producing tradable and nontradable goods that takes world prices and world interest rates as given and is populated by optimizing households and firms. The economy is subject to terms of trade, interest rate, and discount factor shocks. The internal target of the government is the unemployment rate and the external target is the current account. Downward nominal wage rigidity and financial frictions serve as the rationale for meaningful policy intervention.

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Keywords: Internal Balance, External Balance, Small Open Economy, Salter Swan diagram, exchange rate policy, fiscal policy, nontradable goods

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1 Introduction

This paper provides microfoundations to the Salter-Swan policy framework. The Salter-Swan policy framework is a graphical apparatus for policy analysis in small open economies. In this apparatus, the targets of the policy maker are the internal and the external balance of the country. Internal balance means that the economy achieves full employment and price stability. External balance means that the country runs neither excessive current account deficits nor large current account surpluses. The instruments available to the policymaker are the exchange rate and fiscal policy.

The theoretical framework underlying the Salter-Swan policy theory is the tradable and nontradable goods model (also known as the Australian or dependent economy model) in the tradition of Swan (1955), Meade (1956), Salter (1959), Corden (1960), and Dornbusch (1974).[1] The key insight of the tradable and nontradable goods model is the distinction between adjustment in aggregate demand and adjustment in its composition, the so called expenditure switch, when the economy is buffeted by exogenous aggregate disturbances, and the pivotal role played by the relative price of nontradables in facilitating the expenditure switch.

The following example illustrates the adjustment mechanism in the tradable and non-tradable goods model: Suppose the country interest rate premium increases. This generates a contraction in domestic absorption as households and firms substitute future for current spending. Given the relative price of nontradables in terms of tradables (the real exchange rate), the demand for tradables and nontradables falls. The increased gap between tradable output and tradable absorption can be exported. However, the increased gap between supply and demand of nontradables cannot be exported by definition. Thus, market clearing in the nontradable sector requires a decline in the relative price of nontradables. The fall in the relative price of nontradables causes a re-composition of aggregate expenditure away from tradables and toward nontradables and a re-composition of aggregate output in the opposite direction.

In the adjustment mechanism invoked by the tradable and nontradable goods model, the terms of trade (the relative price of exportables in terms of importables) plays no role. In fact, the model assumes that this variable is exogenous. Indeed, in the traditional international trade literature, this is the definition of a small open economy, one that can view the terms of trade as exogenous because it is too small to have any monopoly power. The insight that in a small open economy macroeconomic adjustment does not materialize through changes

[1] For a historical analysis of the development of the dependent economy model, see Metaxas and Weber (2016).

in the terms of trade represented a fundamental departure from the established view at the time of the creation of the Salter-Swan framework.

Although the tradable and nontradable goods model is widely adopted in modern open economy macroeconomics,[2] the key feature that differentiates it from alternative theories of the small open economy continues to be the role played by the relative price of nontradables and the terms of trade in the macroeconomic adjustment process. Specifically, since the seminal work of Galí and Monacelli (2005), a strand of the small open economy literature assumes that all goods are tradable and that the terms of trade are endogenous due to the existence of market power of the small open economy in a subset of world markets. An implication of this modeling strategy is that devaluations affect the small open economy's terms of trade. Recent empirical work by Gopinath et al. (2019) documents that since the emergence of the U.S. dollar as the dominant invoicing currency, the response of the terms of trade to domestic exchange rate changes has become increasingly muted.

The main contribution of this paper is to show that the internal and the external balance schedules of the Salter-Swan policy framework continue to exist in a micro-founded general equilibrium version of the nontradable and tradable goods model. Specifically, the theoretical environment presented in this paper extends the small open economy model developed in Schmitt-Grohé and Uribe (2016) to incorporate government spending, production in the tradable sector, and financial frictions. Meaningful roles for exchange-rate and fiscal policy are motivated by two frictions present in that model: downward nominal wage rigidity and financial constraints. The paper characterizes the adjustment and policy response to terms-of-trade, interest rate, and discount factor shocks.

Employment, which is the internal target of the government, is affected by both, the exchange rate and government spending. Devaluations stimulate labor demand by lowering real wages, and public consumption has an effect on the labor market through an expansion in the demand for nontradables. Since both devaluations and public spending raise the demand for labor, a government that aims to avoid both unemployment and overheating will, all other things equal, move these two instruments in opposite directions. The resulting negative relationship between the nominal exchange rate and government spending captures the internal balance schedule of the Salter-Swan policy framework.

The current account, which is the external target of the government, is also affected by devaluations and government spending. By lowering real wages, devaluations boost employment and output in the traded sector, which tends to improve the current account.

[2] Textbook treatments at the graduate level include Obstfeld and Rogoff (1996, Chapter 4); Frankel (2011, section 3); Végh (2013, Chapter 4); and Uribe and Schmitt-Grohé (2017, Chapters 8 and 9). Abundant references to academic papers using this framework can be found in these books.

At the same time, the increase in tradable output has a positive income effect on tradable consumption, which tends to deteriorate the current account. However, the net effect is positive, because, as dictated by the intertemporal approach to the current account, the marginal propensity to consume out of current income is less than one. An increase in government spending, by elevating domestic absorption, has a direct negative effect on the trade balance. But, indirectly, it also lowers domestic absorption via a negative wealth effect on consumption. The direct effect dominates, however, because, as mentioned, the marginal propensity to consume out of disposable income is small. The fact that devaluations and government spending have opposite effects on the current account implies that if the objective of the government is to keep the current account at a given target level, then these two policy variables must move in the same directions. This prediction of the model gives rise to an external balance schedule like the one in the Salter-Swan policy framework.

The intersection of the internal balance and the external balance schedules determines the desired policy mix for the nominal exchange rate and the level of government spending. At these values of the policy instruments, the current account and the level of employment achieve their respective target levels. The resulting apparatus allows for the analysis of the government policy reaction to internal and external aggregate disturbances. The contribution of the present paper is to derive the internal and external balance schedules of the Salter-Swan model as the outcome of a micro-founded dynamic general equilibrium model of a small open economy.

One undesirable prediction of the Salter-Swan framework is that the government must respond to an exogenous increase in the costs of external funds with a fiscal expansion so as to avoid too large a current account surplus. In policy debates fiscal expansions are typically summoned to stimulate domestic demand and not for the sole purpose of lowering current account surpluses. This counterfactual implication of the Salter-Swan model is a consequence of the assumption that the government has an ad hoc fixed target for the current account balance. To overcome this limitation, in an extension, the paper adds an extra layer of microfoundations to the Salter-Swan model by introducing financial frictions in the form of a collateral constraint on external borrowing of the type often used in the sudden stop literature (Mendoza, 2002; Uribe, 2006; Korinek, 2011; Bianchi, 2011; Benigno et al., 2013 and 2016; Schmitt-Grohé and Uribe, 2017 and 2020). In the presence of collateral constraints the external objective becomes one whereby the government dislikes current account deficits but does not mind current account surpluses. In this version of the model, an in the costs of external funds does not put the country off its external balance since sudden stops generate current account reversals even in the absence of government intervention. However, it does put it off its internal balance, since absent policy intervention, it causes involuntary unemployment. A currency depreciation, by eroding real wages, turns out to be a sufficient instrument to restore internal balance.

This paper is related to a literature in which the external and internal balance framework is derived in the context of models in which all goods are internationally tradable. In this class of models it is assumed that the economy is large enough to be able to alter its terms of trade through exchange rate and fiscal policy. An early contribution along these lines is Meade (1951) and a textbook treatment can be found in Caves, Frankel, and Jones (2007, Chapter 18). The emphasis of this line of research on the effects of policy on the terms of trade is relevant for large advanced economies in light of the empirical fact that for such economies movements in the real exchange rate materialize largely through movements in the relative price of internationally traded goods (Engel, 1999).

The remainder of the paper is organized in nine sections. Section 2 presents the model. Section 3 characterizes the equilibrium. Sections 4 and 5 derive the internal balance and the external balance schedules, respectively. Section 6 analyzes the policy response to terms-of-trade shocks using the derived microfounded Salter-Swan diagram. Section 7 analyzes the policy response to interest rate shocks. Section 8 uses the new Salter-Swan framework to study how the policy response changes when external borrowing is subject to a collateral constraint. Section 9 characterizes the effects of a domestic demand shock taking the form of an increase in the subjective discount factor. Section 10 closes the paper with a discussion of the results.

2 The Model

Consider an open economy that produces and consumes tradable and nontradable goods. Suppose that the economy is small in the sense that it takes as given the foreign price of the tradable good and the world interest rate. In both sectors, output is assumed to be produced with labor. Also, labor is assumed to be perfectly mobile across sectors. Short-run adjustment is hindered by the presence of downward nominal wage rigidity, as in Schmitt-Grohé and Uribe (2016). The government can affect the allocation of resources via fiscal and exchange-rate policy. These are the basic ingredients of the Salter-Swan model.

For expositional convenience, we consider a perfect foresight economy that suffers a variety of temporary domestic and external shocks, including terms-of-trade shocks, productivity shocks, and country-spread shocks. We assume that one period after a purely temporary shock wages adjust flexibly to ensure full employment.

2.1 Households

The economy is populated by identical infinitely-lived households with preferences described by the utility function

$$\sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}-1}{1-\sigma},$$

where c_t denotes consumption, $\beta \in (0,1)$ denotes the subjective discount factor, and $\sigma > 0$ denotes the intertemporal elasticity of consumption substitution.

Consumption is assumed to be a composite of tradable and nontradable goods, with a CES Armington aggregator,

$$c_t = A(c_t^T, c_t^N) \equiv \left[a(c_t^T)^{1-\frac{1}{\xi}} + (1-a)(c_t^N)^{1-\frac{1}{\xi}}\right]^{\frac{1}{1-\frac{1}{\xi}}},$$

where c_t^T and c_t^N denote consumption of tradable and nontradable goods, respectively, $\xi > 0$ is a parameter representing the intratemporal elasticity of consumption substitution, and $a \in (0,1)$ is a parameter representing the importance of tradables and nontradables in utility. To facilitate the analysis, we assume that the intra- and intertemporal elasticities of substitution are equal to each other,

$$\xi = \frac{1}{\sigma},$$

which implies that preferences are separable in tradable and nontradable consumption. This restriction is empirically appealing. Existing econometric studies point to a value of ξ of around 0.5 for emerging countries (see the survey by Akinci, 2011). And a value for the intertemporal elasticity of substitution σ of 2 is commonplace in quantitative business-cycle analysis.

Households are assumed to have access to foreign-currency denominated financial instruments that allow them to borrow or lend at the world interest rate $r > 0$. They are endowed with $\bar{h}$ hours each period, which they supply to the labor market inelastically. However, households may not be able to sell all $\bar{h}$ hours. Let $h_t \leq \bar{h}$ be the hours actually worked in period t. The sequential budget constraint of the household is then given by

$$P_t^T c_t^T + P_t^N c_t^N + \mathcal{E}_t d_t + T_t = W_t h_t + \Phi_t + \mathcal{E}_t \frac{d_{t+1}}{1+r},$$

where P_t^T denotes the domestic price of an internationally traded good imported by the household, P_t^N denotes the price of nontradable goods, $\mathcal{E}_t$ denotes the nominal exchange rate defined as the domestic-currency price of one unit of foreign currency, W_t denotes the nominal hourly wage rate, d_t denotes foreign-currency denominated debt due in period t, and Φ_t denotes profits received from the ownership of firms.

The law of one price holds for tradable goods, which is a key assumption of the Salter-Swan framework. This assumption is also empirically plausible for most countries, especially since the emergence of the U.S. dollar as a dominant currency for invoicing of trade (Gopinath, et al., 2019). Letting P_t^{T*} denote the world price of the tradable good expressed in foreign currency, we then have that

$$P_t^T = \mathcal{E}_t P_t^{T*}.$$

A second important characteristic of the Salter-Swan model is that the economy is small. This implies that P_t^{T*} is exogenous to the domestic economy. For simplicity, we normalize it to unity, $P_t^{T*} = 1$, which implies that the domestic price of the imported tradable good equals the nominal exchange rate,

$$P_t^T = \mathcal{E}_t.$$

Dividing the right- and left-hand sides of the sequential budget constraint by the nominal exchange rate, we can write

$$c_t^T + p_t c_t^N + d_t + \tau_t = w_t h_t + \phi_t + \frac{d_{t+1}}{1+r}, \tag{1}$$

where $p_t \equiv P_t^N/\mathcal{E}_t$ denotes the relative price of nontradables in terms of tradables, $w_t \equiv W_t/\mathcal{E}_t$ denotes the real wage rate expressed in units of tradables, and τ_t and ϕ_t denote tax payments and profits also in units of tradables. The variable $1/p_t$ is often referred to as the real exchange rate because it determines the relative price of a unit of consumption in the foreign country in units of consumption in the domestic country.

The household chooses sequences $\{c_t, c_t^T, c_t^N, d_{t+1}\}_{t=0}^{\infty}$ to maximize its lifetime utility function subject to its sequential budget constraint and to a no-Ponzi-game constraint of the form $\lim_{t\to\infty}(1+r)^{-t}d_t \leq 0$. Because preferences are strictly increasing in consumption, at the optimum the no-Ponzi-game constraint holds with equality,

$$\lim_{t\to\infty}(1+r)^{-t}d_t = 0. \tag{2}$$

The first-order conditions associated with the household's optimization problem are the budget constraint (2) and

$$p_t = \frac{A_2(c_t^T, c_t^N)}{A_1(c_t^T, c_t^N)} \tag{3}$$

and

$$\left(\frac{c_{t+1}^T}{c_t^T}\right)^\sigma = \beta(1+r). \tag{4}$$

To avoid an inessential trend in consumption of tradables, we assume that the subjective and market discount rates are equal to each other,

$$\beta(1+r) = 1.$$

This assumption and the Euler equation (4) imply that consumption of tradables is constant over time. So we can write

$$c_t^T = c^T,$$

where c^T is a constant to be determined in equilibrium.

2.2 Firms

Firms in the traded and nontraded sectors use labor as the sole input. The production technologies take the form

$$y_t^T = A_t^T F_T(h_t^T)$$

and

$$y_t^N = A_t^N F_N(h_t^N), \tag{5}$$

where y_t^i, h_t^i, A_t^i, and F_i, for $i = T, N$, denote output, labor input, a productivity shock, and the production function in the traded and nontraded sectors, respectively. The production functions are assumed to be increasing and strictly concave.

The internationally traded output, y_t^T, is assumed to be exported at the price P_t^X. We assume that the law of one price holds for the exported tradable good, that is,

$$P_t^X = \mathcal{E}_t P_t^{X*},$$

where P_t^{X*} denotes the international price of the exported tradable good expressed in foreign currency. The country is assumed to be a price taker in the market for the exported good.

The country's terms of trade, which we denote by p_t^x, is given by the ratio of export to import prices, that is,

$$p_t^x \equiv \frac{P_t^X}{P_t^T} = \frac{P_t^{X*}}{P_t^{T*}}.$$

The country takes p_t^x as exogenous.

The problem of the firm is to chose employment to maximize profits, which are given by

$$p_t^x A_t^T F_T(h_t^T) + p_t A_t^N F_N(h_t^N) - w_t(h_t^T + h_t^N).$$

The optimal demand for labor equalizes the value of the marginal product of labor to the wage rate in each sector,

$$p_t^x A_t^T F_T'(h_t^T) = w_t \tag{6}$$

and

$$p_t A_t^N F_N'(h_t^N) = w_t. \tag{7}$$

These two expressions are standard sectoral demands for labor. The higher the real wage is, the lower the demand for labor in each sector will be. Also, the higher the relative price of exportables (nontradables) is, the higher the demand for labor in the exportable (nontraded) sector will be.

2.3 The Monetary and Fiscal Authorities

The monetary authority sets the nominal exchange rate, $\mathcal{E}_t$. The fiscal authority levies lump-sum taxes, τ_t, and consumes imported tradable goods and nontradable goods. We assume that the government consumes these two goods in fixed proportions. Specifically, public consumption of nontradables is denoted g_t and public consumption of tradables γg_t, where $\gamma > 0$ is a parameter. We assume that the government starts with no debt and maintains a balanced budget each period, so its sequential budget constraint, expressed in units of tradable goods, is given by

$$\tau_t = g_t(\gamma + p_t).$$

2.4 Market Clearing

In equilibrium, the market for nontradable goods must clear, that is,

$$c_t^N + g_t = y_t^N. \tag{8}$$

In addition, employment cannot exceed the time endowment. Letting

$$h_t \equiv h_t^T + h_t^N \tag{9}$$

denote employment in period t, we have that h_t must satisfy

$$h_t \leq \bar{h}.$$

Combining the sequential budget constraints of the government and the household, we have that external debt evolves according to

$$c_t^T + \gamma g_t + d_t = p_t^x y_t^T + \frac{d_{t+1}}{1+r}.$$

The household is assumed to start period 0 without any debt, $d_0 = 0$. Then, substituting this expression repeatedly into itself and using the transversality condition (2) yields

$$c^T = \frac{r}{1+r} \sum_{t=0}^{\infty} \left(\frac{1}{1+r} \right)^t (p_t^x y_t^T - \gamma g_t). \tag{10}$$

This expression says that each period domestic consumption of traded goods equals the annuity value of the stream of current and future expected disposable tradable income. It represents the backbone of the intertemporal approach to the current account.

3 Equilibrium

To fix ideas, consider the effects of a purely transitory deterioration in the terms-of-trade, p_t^x. (Since p_t^x and A_t^T are both exogenous and always appear multiplying each other, we could equivalently interpret the shock as a drop in labor productivity in the export sector, A_t^T.) Specifically, suppose that before period 0 the terms of trade were at a steady-state level p_{ss}^x, and that in period 0 they unexpectedly drop to $p^x < p_{ss}^x$. Suppose further that in period 1 p_t^x returns to its long-run value p_{ss}^x and stays at that level thereafter. In period 0, agents understand that the fall in the terms of trade is purely transitory. Suppose that prior to period 0, the economy was in a steady state with full employment. Since there are no shocks after period 0 and the nominal wage is assumed to adjust flexibly when period 0 is over, we have that in period 1 the economy reaches a steady state with full employment. The focus of the analysis is the effect of the terms-of-trade deterioration on employment and the current account in period 0. To facilitate notation we drop the time subscript to denote values prevailing in period 0 and denote steady-state values after period 0 with the subscript ss. Recall that the nominal wage rate in period 0, W, is predetermined. This will be the source of imbalances when shocks hit the economy. We assume that government spending is nil before and after the shock, $g_t = 0$, for $t \neq 0$, and we normalize the productivity factors in the traded and nontraded sectors to unity, $A_t^T = A_t^N = 1$, for all t.

Combining the household's optimality condition, (3), the firm's optimality conditions (5)-(7), and the market clearing conditions, (8) and (9), in period 0, we obtain

$$p = \frac{A_2(c^T, F_N(h-h^T)-g)}{A_1(c^T, F_N(h-h^T)-g)}, \tag{11}$$

$$p = \frac{W/\mathcal{E}}{F_N'(h-h^T)}, \tag{12}$$

and

$$p^x F_T'(h^T) = W/\mathcal{E}. \tag{13}$$

The intertemporal resource constraint (10) and the fact that the economy is in a full-employment steady state starting in period 1 imply that

$$c^T + \frac{\gamma r}{1+r} g = \frac{r}{1+r} p^x F_T(h^T) + \frac{1}{1+r} p^x_{ss} F_T(h^T_{ss}). \tag{14}$$

Finally, because the economy is in a full-employment steady state starting in period 1, we have that h^T_{ss} is determined by the expression

$$\frac{A_2(c^T, F_N(\bar{h}-h^T_{ss}))}{A_1(c^T, F_N(\bar{h}-h^T_{ss}))} = \frac{p^x_{ss} F_T'(h^T_{ss})}{F_N'(\bar{h}-h^T_{ss})}. \tag{15}$$

Equilibrium conditions (11)-(15) form a system of five equations in five unknowns, c^T, p, h, h^T, and h^T_{ss}, given the prices W and p^x, and the policy variables $\mathcal{E}$ and g. To ensure that labor demand in period 0 does not exceed labor supply in equilibrium, it must be the case that $0 < h^T < h \leq \bar{h}$. Since we are considering an adverse shock, namely, a fall in p^x, which, absent a policy change would require a fall in nominal wages to achieve full employment, and since the nominal wage is assumed to be downwardly rigid, we take W to be predetermined.

4 Internal Balance

Because the aggregator function is concave and the production functions are increasing and concave, equation (15) implies that h^T_{ss} is a strictly decreasing function of c^T, which we write as

$$h^T_{ss} = H^T_{ss}(\underset{-}{c^T}).$$

Intuitively, because tradable and nontradable goods are normal goods, a higher steady-state level of tradable consumption must go hand-in-hand with higher consumption of nontradables. The only way in which the economy can produce more nontradables is by employing more hours in the nontradable sector, which in turn requires reducing employment in the traded sector, as the economy operates at full employment in the steady state.

Combining this expression with equilibrium conditions (13) and (14) yields the following equation determining the equilibrium level of tradable consumption:

$$c^T + \frac{\gamma r}{1+r} g = \frac{r}{1+r} p^x F_T\left(F_T'^{-1}\left(\frac{W/\mathcal{E}}{p^x}\right)\right) + \frac{1}{1+r} p^x_{ss} F_T(H^T_{ss}(c^T)).$$

Solving for c^T, we can write

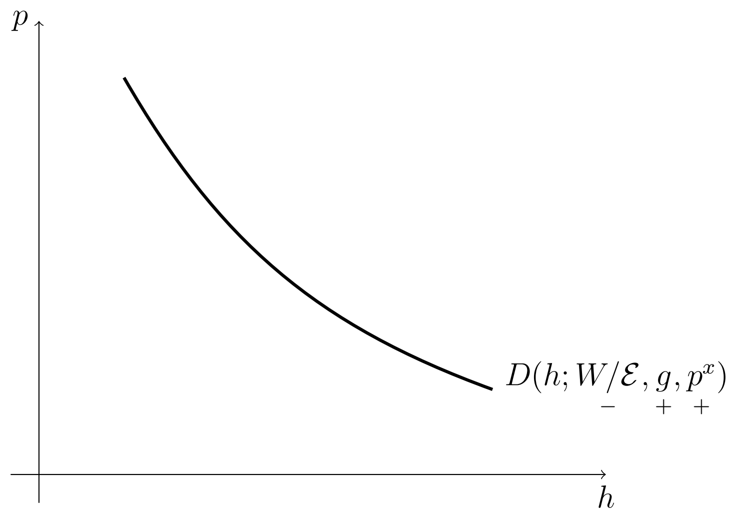
$$c^T = C^T(\underset{-}{W/\mathcal{E}}, \underset{-}{\gamma g}, \underset{+}{p^x}). \tag{16}$$

The negative sign below the real wage might sound counterintuitive, for it says that an increase in hourly earnings causes a fall in the consumption of tradable goods. This interpretation, however, does not take into account that equation (16) is an equilibrium object. An increase in the real wage, $W/\mathcal{E}$, reduces employment in the tradable sector and therefore tradable output as well, which in turn reduces the amount of tradable consumption that can be supported in equilibrium. Given the nominal wage, W, a depreciation of the domestic currency (an increase in $\mathcal{E}$), by reducing the real wage, boosts private consumption of tradables. An increase in public consumption of tradables, γg, crowds out private consumption of this type of good, because, given the real wage, the supply of tradables is fixed. Notice however, that this crowding out effect is relatively small. To see this note that equation (14) implies that the marginal propensity to consume out of a transitory increase in private tradable income (i.e., the increase in c^T in response to a unit increase in $y^T - \gamma g$) is small and given by

$$\text{marginal propensity to consume} = \frac{r}{1+r}\left[1 - \frac{1}{1+r} p^x_{ss} F_T'(h^T_{ss}) H^{T\prime}_{ss}(c^T)\right]^{-1} < r. \tag{17}$$

This is a standard result in the intertemporal approach to the current account: Households use the current account to finance transitory disturbances in tradable income, which allows them to smooth tradable consumption over time. Finally, an appreciation of the terms of trade, that is, an increase in p^x, raises the value of tradable output in terms of imported goods (both directly and indirectly by inducing an increase in employment), which in turn elevates the level of tradable consumption that can be supported in equilibrium.

Figure 1: The Demand for Labor Derived from the Demand for Goods



Using equations (13) and (16) to eliminate h^T and c^T from equation (11) yields

$$p = \frac{A_2\left(C^T(W/\mathcal{E}, \gamma g, p^x), F_N\left(h - {F_T'}^{-1}\left(\frac{W/\mathcal{E}}{p^x}\right)\right) - g\right)}{A_1\left(C^T(W/\mathcal{E}, \gamma g, p^x), F_N\left(h - {F_T'}^{-1}\left(\frac{W/\mathcal{E}}{p^x}\right)\right) - g\right)}, \tag{18}$$

which we can write more compactly as

$$p = D(\underset{-}{h}; \underset{-}{W/\mathcal{E}}, \underset{+}{g}, \underset{+}{p^x}). \tag{19}$$

Figure 1 depicts this relationship in the space (h, p). The function D is a complex equilibrium condition, but it primarily captures the demand for labor derived from the demand for nontradable goods (with the second occurrence of the word 'demand' determining the use of the letter D in denominating the function): an increase in the relative price of nontradables, p, causes a reduction in the demand for nontradables, which, given the real wage, induces firms to cut the demand for labor.

Consider now the intuition behind the negative sign underneath the real wage rate, $W/\mathcal{E}$. As discuss earlier, an increase in real labor costs depresses both the demand for tradable goods, c^T, and employment in the tradable sector, h^T. The former effect lowers the demand for nontradables, and the latter increases the supply of nontradables (because, holding constant h, a fall in h^T implies an increase in h^N). Both effects put downward pressure on the price of nontradables.

The relationship between government spending, g, and the relative price of nontradables, p, holding constant h, is in principle ambiguous, but most likely positive. On the one hand, an increase in the public demand for nontradable goods reduces one for one the supply of nontradable goods disposable for private consumption, $y^N - g$,—the second argument of the numerator and denominator of the right hand side of equation (18)—elevating the price of nontradables that clears the market. This is a direct effect. On the other hand, an increase in (nonproductive) government consumption makes households poorer, which reduces the demand for consumption goods,—the first argument of the numerator and denominator of the right hand side of equation (18)—thereby depressing the price of nontradables. This effect is indirect and, as we argue next, small. Recall that the crowding out effect of a transitory increase in government spending on tradable consumption is given by the marginal propensity to consume (equation 17), which is less than r. Also, typically government spending is concentrated on goods with a significant nontraded component, such as administrative services, education, and health, and not on tradable goods (small γ). Thus, the most likely scenario is one in which the partial derivative of the function D with respect to g is positive. For the remainder of the paper, we will assume that this is indeed the case.

Finally, the function $D(h; W/\mathcal{E}, g, p^x)$ is increasing in p^x. A terms of trade appreciation makes households richer, which boosts the demand for consumption and puts upward pressure on the relative price of nontradable consumption goods. Furthermore, a rise in the terms of trade drives up employment in the traded sector, reducing, holding constant total employment, the number of hours available for the production of nontradables. This in turn results in a reduction in the supply of nontradable goods, which requires an increase in the equilibrium relative price of nontradables.

Now use equation (13) to eliminate h^T from equilibrium condition (12). This yields

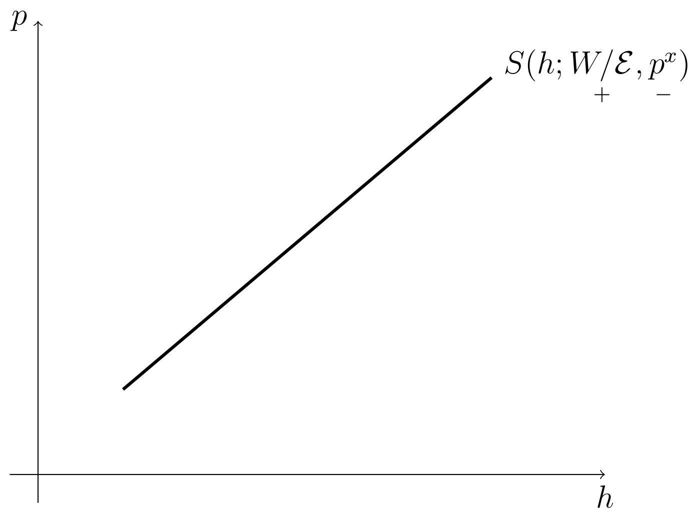
$$p = \frac{W/\mathcal{E}}{F_N'\left(h - F_T'^{-1}\left(\frac{W/\mathcal{E}}{p^x}\right)\right)}, \tag{20}$$

which, in compact form, can be written as

$$p = S(\underset{+}{h}; \underset{+}{W/\mathcal{E}}, \underset{-}{p^x}). \tag{21}$$

We denote this function S because it primarily reflects the demand for labor derived from the supply of nontradable goods. Figure 2 depicts the relationship between total employment, h, and the relative price of nontradables, p, implied by this function. Given the real wage, $W/\mathcal{E}$, and the terms of trade, p^x, employment in the traded sector is fixed (equation (13)). Thus, an increase in total employment h must be fully allocated to the nontradable sector.

Figure 2: The Demand for Labor Derived from the Supply of Goods



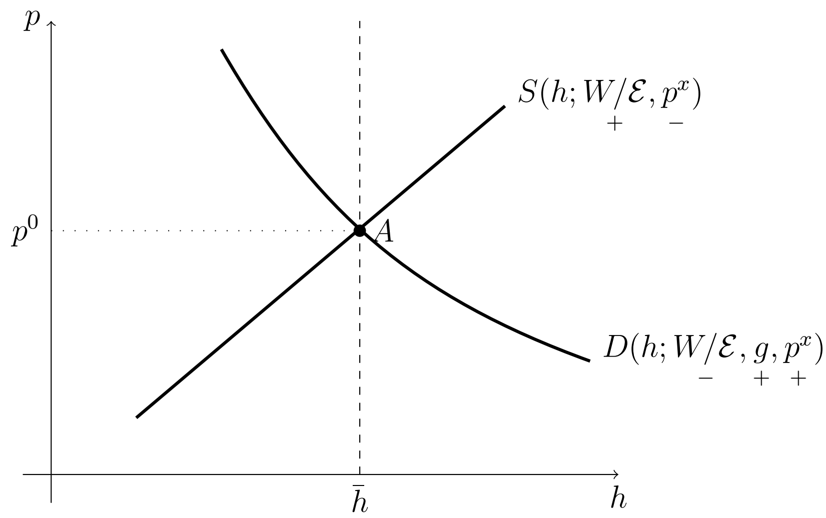
To voluntarily employ this increased supply of labor, firms require an increase in the price of nontradables.

An increase in the real wage shifts the function S up and to the left. This is so for two reasons. First, if the cost of labor increases, firms require a higher price to continue hiring the same number of hours. Second, an increase in labor costs reduces employment in the traded sector, which, given total employment, increases the number of hours employed in the nontraded sector. This requires an increase in the price for firms in the nontraded sector to be willing to absorb the labor coming from the tradable sector. Finally, an improvement in the terms of trade, an increase in p^x, induces an increase in employment in the traded sector, which reduces, given h, the availability of hours in the nontraded sector. For firms in the nontraded sector to be willing to cut employment, the price of the good they produce must fall.

In equilibrium, the demand for labor derived from the demand for nontradable goods and the demand for labor derived from the supply of nontradable goods must equal each other, as the market for nontradables must clear. The situation is depicted in Figure 3. The equilibrium occurs at point A. As the figure is constructed, at point A the economy operates at full employment ($h = \bar{h}$) and the equilibrium real exchange rate is p^0. As we will see next, however, full employment need not obtain in equilibrium because the economy suffers from nominal wage rigidity.

Consider the effect of a temporary decline in the terms of trade. Specifically, suppose that the relative price of exportables in terms of importables, p^x, falls to $p^{x'} < p^x$. In response

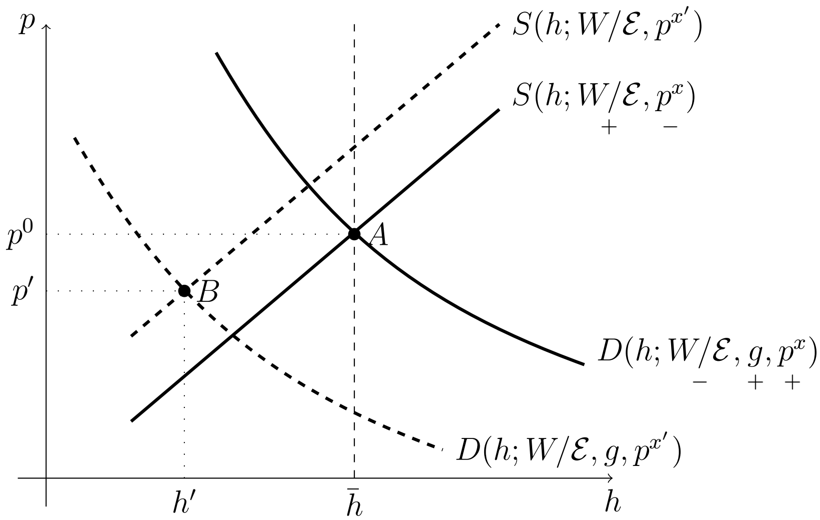
Figure 3: Equilibrium Determination of Employment and the Real Exchange Rate



to this shock, the D and S schedules both shift to the left, as shown in Figure 4. The new equilibrium occurs at point B. The negative disturbance causes involuntary unemployment in the amount $\bar{h} - h'$. The reason is that because the nominal wage is downwardly rigid and the monetary authority keeps the nominal exchange rate fixed, the real wage stays at its pre-shock level, which causes firms in the traded sector to cut employment in response to the exogenous decline in the world price of the good they produce. In addition, at the pre-shock real wage and relative price of nontradables, firms in the nontraded sector are unwilling to hire the displaced workers. Inspection of equations (18) and (20) (the primitives of the schedules D and S, respectively) reveals that the shift in the D schedule is larger than the shift in the S schedule, so that, as shown in Figure 4, p falls (or the real exchange rate depreciates). Thus the dominant effect is that the negative terms-of-trade shock makes households poorer, inducing them to cut consumption, which in turn depresses the relative price of the nontraded good. Because of downward nominal wage rigidity and the central bank's keeping the exchange rate unchanged, the real wage is unchanged. Facing lower prices and unchanged marginal costs, firms in the nontraded sector, like firms in the traded sector, cut employment. As a result of the negative terms-of-trade shock, the economy suffers involuntary unemployment.

In a more realistic setting in which the terms of trade shock is persistent as opposed to purely temporary and nominal wages are downwardly rigid for more than one period, the absence of policy intervention would give rise to a protracted spell of elevated unemployment.

Figure 4: Equilibrium Response of Employment and the Real Exchange Rate to a Deterioration in the Terms of Trade

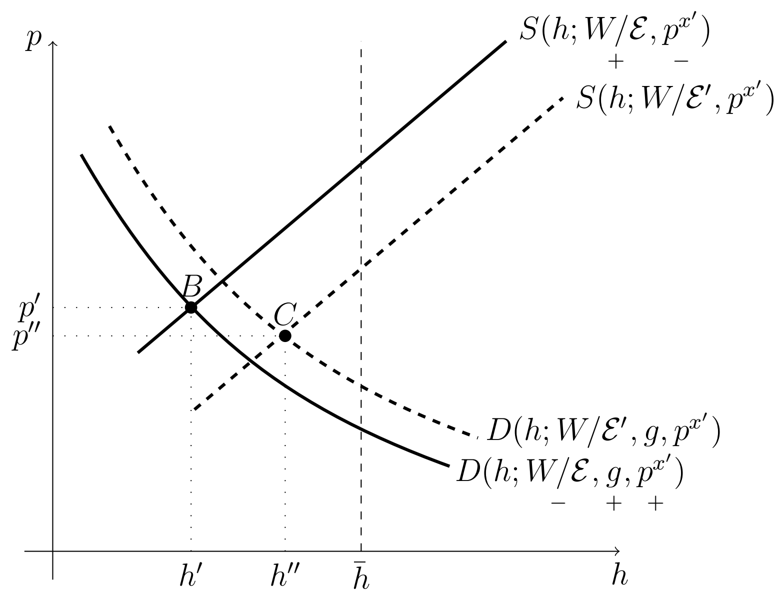


Note. $p^{x\prime} < p^x$.

As time goes by, nominal wages would gradually decline reducing real labor costs and slowly restoring full employment. Graphically, this adjustment process would consist in a gradual shift of both the demand and the supply schedules to the right until their intersection takes place at $h_t = \bar{h}$.

Consider now the role of exchange-rate policy in restoring full employment. Figure 5 picks up from the equilibrium with unemployment following a deterioration in the terms of trade depicted in Figure 4. Prior to the devaluation, the economy is at point B, where unemployment equals $\bar{h} - h'$. Suppose that the government devalues the domestic currency from $\mathcal{E}$ to $\mathcal{E}' > \mathcal{E}$. This policy intervention causes the D schedule to shift up and the S schedule to shift down. The new equilibrium is at point C, where unemployment is lower ($\bar{h} - h'' < \bar{h} - h'$). The intuition why a devaluation is expansionary is as follows: In the initial situation (point B), the real wage is too high to clear the labor market. Unemployment puts downward pressure on the real wage, but this variable is downwardly rigid due to the combination of nominal wage rigidity and a given exchange rate. The devaluation lowers the real wage fostering employment by firms in both the traded and the nontraded sectors. As Figure 5 is constructed, the economy continues to have involuntary unemployment after the devaluation. However, a sufficiently large devaluation would have restored full employment. Beyond this level, devaluations have no additional real effects and cause wage and price inflation.

Figure 5: Effect of a Devaluation on Employment and the Real Exchange Rate



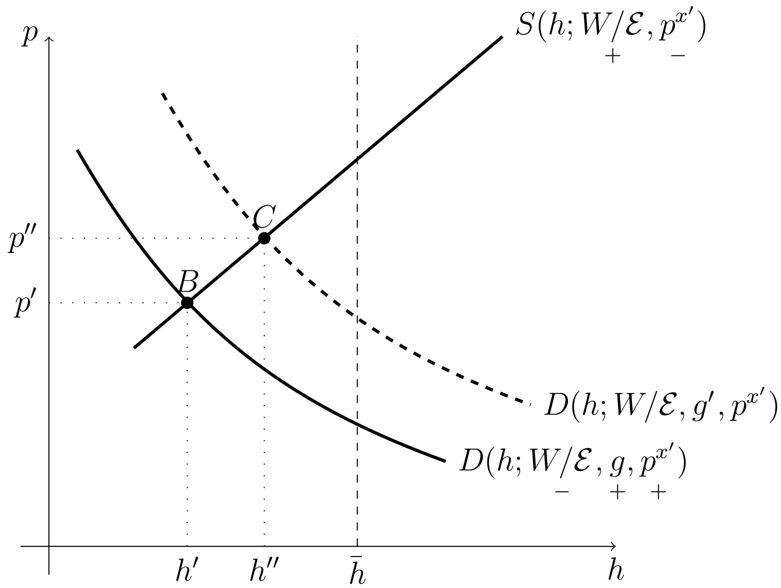
Note. $\mathcal{E}' > \mathcal{E}$.

The effect of a devaluation on the relative price of nontradables, p, is in principle ambiguous, because the downward shift in the S schedule tends to make nontradables less expensive, whereas the upward shift in the D schedule has the opposite effect. However, the movement in the S schedule is likely to dominate, so that the relative price of nontradables is likely to fall (i.e., the real exchange rate is likely to depreciate). The reason why the shift in the D schedule is small is that, although the devaluation causes an expansion in the demand for nontradables via an income effect stemming from a positive effect of the devaluation on the production of tradable goods, y^T, the marginal propensity to consume out of a transitory increase in tradable income is small, less than r (see equation (17)).

Another policy instrument available to the government to reduce unemployment is government spending, g. As before, suppose that the initial situation is one in which, due to a deterioration in its terms of trade, the economy is experiencing involuntary unemployment, as at point B in Figure 6. Suppose that the government increases public consumption from g to $g' > g$. The fiscal expansion shifts the D schedule up, but leaves the S schedule unchanged. The new equilibrium is at point C, with lower unemployment (hours worked increase from h' to h'') and a more appreciated real exchange rate (the relative price of nontradables increases from p' to $p'' > p'$).[3] All of the increase in employment occurs in

[3]Empirically, increases in government spending have been found to cause real exchange rate appreciation

Figure 6: Effect of an Increase in Government Spending on Employment and the Real Exchange Rate



Note. $g' > g$.

the nontraded sector. Recall that employment in the traded sector depends only on the real wage and the terms of trade (equation 13), both of which are unchanged. Firms in the nontraded sector expand employment incentivized by an increase in the relative price of the good they produce, p. In turn, p increases because government spending puts pressure on the aggregate absorption of nontradables.

The increase in the demand for labor brought about by the fiscal expansion does not result in nominal wage inflation, because, as the figure is drawn, the economy continues to suffer unemployment, $h'' < \bar{h}$. A sufficiently large fiscal stimulus, all other things equal, could create a demand for labor larger than $\bar{h}$, which would cause nominal wages to rise.

Unlike in the classic IS-LM model, in the present model government spending crowds out private consumption. In fact, it crowds out both tradable and nontradable consumption. Tradable consumption falls because the higher taxes required to finance the elevation in public spending have a negative wealth effect. Nontradable consumption falls for the same reason and because of the increase in the relative price of nontradables.

Comparing the exchange-rate policy and the fiscal policy responses to the unemployment

in developing countries (Miyamoto, Nguyen, and Sheremirov; 2019) and depreciation in advanced countries (Monacelli and Perotti, 2010; Ravn, Schmitt-Grohé and Uribe, 2012).

caused by the deterioration in the terms of trade, we note that, while both policies are effective at reducing unemployment, the former induces a depreciation of the real exchange rate (a fall in p) and the latter an appreciation (an increase in p).

Summing up, we have established that the equilibrium level of employment, given by the solution for h of the equilibrium condition

$$D(h; W/\mathcal{E}, g, p^x) = S(h; W/\mathcal{E}, p^x)$$

depends positively on the nominal exchange rate, $\mathcal{E}$, the level of government spending, g, and the terms of trade, p^x. We can write this equilibrium relationship as

$$h = H(\underset{+}{\mathcal{E}}, \underset{+}{g}, \underset{+}{p^x}).$$

To avoid clutter, we do not include W in this expression because throughout the analysis that follows the downward nominal wage rigidity is assumed to be binding.

Consider now the government-spending and exchange-rate combinations, $(g, \mathcal{E})$, that guarantee full employment, $h = \bar{h}$. This relationship is implicitly given by the equation

$$\bar{h} = H(\mathcal{E}, g; p^x).$$

Solving for $\mathcal{E}$, we obtain

$$\mathcal{E} = I(\underset{-}{g}; \underset{-}{p^x}). \tag{22}$$

This is the microfounded version of the Internal Balance schedule in the Salter-Swan model. It is depicted in Figure 7 as a downward sloping relationship in the space $(g, \mathcal{E})$. Because devaluations and increases in government spending both foster employment, the Internal Balance schedule is downward sloping.

For pairs $(g, \mathcal{E})$ below the Internal Balance schedule, the economy suffers from involuntary unemployment. For policy mixes above the schedule, there is full employment and further economic stimulus leads to excessive price and wage inflation.

Consider now a terms-of-trade deterioration (a fall in p^x). This shock shifts the Internal Balance schedule up, as shown in Figure 8. This is because, holding policy constant, a terms-of-trade decline causes unemployment. As a result, for a given nominal exchange rate, the government needs to increase government spending to achieve full employment. Alternatively, for a given level of government spending, the government must devalue the currency to return to full employment.

Figure 7: The Internal Balance Schedule

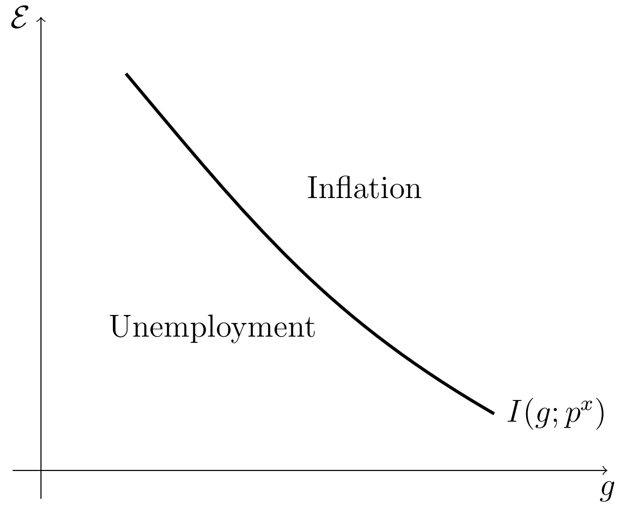
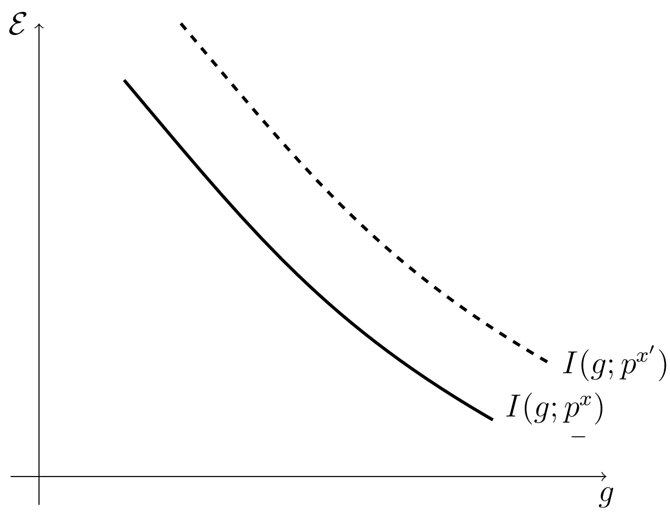


Figure 8: The Internal Balance Schedule and a Negative Terms-of-Trade Shock



Note. $p^{x'} < p^x$.

5 External Balance

The current account in period 0, denoted ca, is given by the difference between tradable output, y^T, and domestic absorption of tradable goods, that is,

$$ca = p^x y^T - c^T - \gamma g.$$

Debt service is nil in period 0, due to the assumption that the country starts with no external debt ($d_0 = 0$), so in period 0 the current account is equal to the trade balance. Using equations (13) and (16) we can write the equilibrium current account balance as

$$ca = p^x F_T \left(F_T'^{-1} \left(\frac{W/\mathcal{E}}{p^x} \right) \right) - C^T(W/\mathcal{E}, \gamma g, p^x) - \gamma g. \tag{23}$$

Recalling that the marginal propensity to consume tradable goods out of a transitory increase in tradable income is smaller than r (equation (17)), we have that the current account is unambiguously increasing in the exchange rate, $\mathcal{E}$, and the terms of trade, p^x, and decreasing in government spending, g. The intuition is as follows: with downward nominal wage rigidity, a devaluation reduces the real wage, fostering employment and output in the traded sector. The increase in tradable output has a positive income effect on tradable consumption, but smaller than the increase in output itself, so the trade balance and the current account improve. An increase in government consumption of tradables reduces the current account one-for-one. It also causes a negative wealth effect that depresses private consumption of tradables, but this effect is too small to offset the direct effect, and the current account deteriorates. An increase in the terms of trade increases the value of traded output and induces higher domestic consumption of tradables. However, the former effect dominates the latter, so that the current account improves. We can therefore write these relationships more compactly as

$$ca = CA(\underset{+}{\mathcal{E}}, \underset{-}{g}, \underset{+}{p^x}). \tag{24}$$

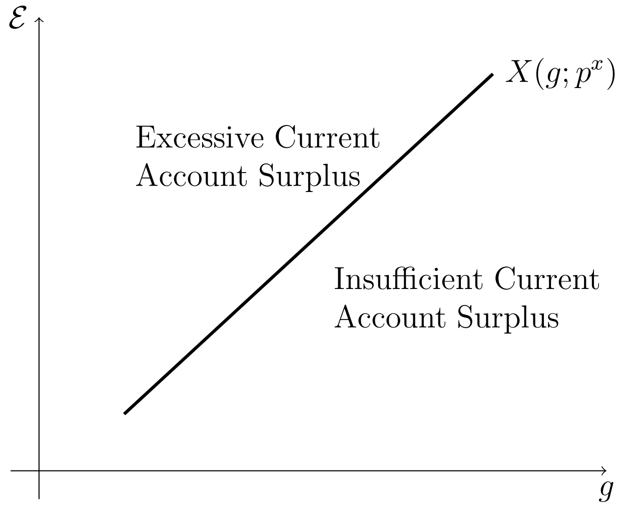
As we did with the Internal Balance schedule, we now ask what are the combinations of fiscal and exchange-rate policy that guarantee a desired level $\overline{ca}$ for the current account. From equation (24), we have that these pairs are implicitly given by

$$\overline{ca} = CA(\mathcal{E}, g, p^x).$$

Solving for $\mathcal{E}$ yields

$$\mathcal{E} = X(\underset{+}{g}; \underset{-}{p^x}). \tag{25}$$

Figure 9: The External Balance Schedule



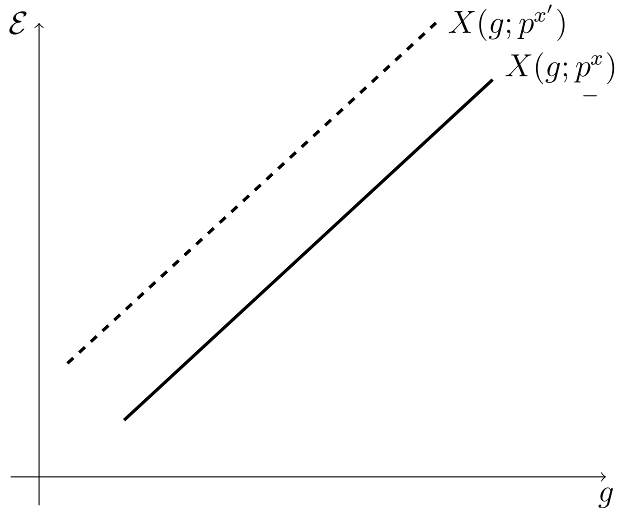
This expression is a microfounded version of the External Balance schedule in the Salter-Swan model. It is depicted in Figure 9. It is upward sloping because an increase in government spending deteriorates the current account, which requires a depreciation to restore the desired level of external balance.

A negative terms-of-trade shock (a fall in p^x) shifts the External Balance schedule upward, as shown in Figure 10. This is because, holding policy variables constant, the decline in the terms of trade worsens the current account, requiring either a depreciation or a cut in government spending to restore external balance.

6 Determination of the Policy Mix

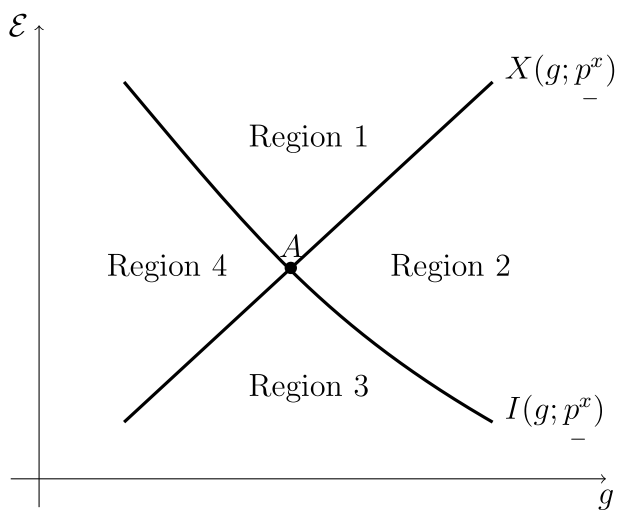
With the Internal and External Balance schedules in hand, we can determine the fiscal and exchange-rate policy mix that achieves the employment and current-account targets of the government. Figure 11 provides a graphical representation of the determination of the policy mix. It represents the microfounded version of the celebrated Salter-Swan diagram. The desired policy mix occurs at point A, where the I and X schedules intersect. The two schedules divide the policy space $(g, \mathcal{E})$ into four regions. Region 1, located above the I and X schedules is characterized by overheating on the internal front and an excessively large current account balance on the external front. Region 2, located above the I schedule and below the X schedule, features overheating and an insufficient current account balance.

Figure 10: The External Balance Schedule and a Negative Terms-of-Trade Shock



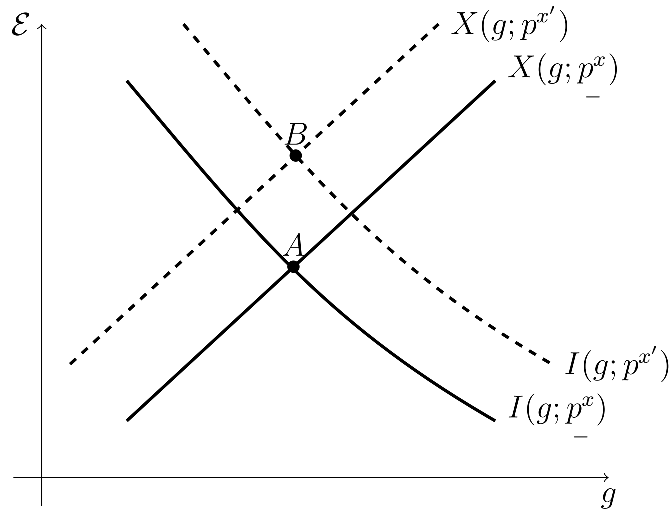
Note. $p^{x'} < p^x$.

Figure 11: The Four Regions of Exchange-Rate and Fiscal Policy



Notes. Region 1: Overheating and excessive current account surplus. Region 2: Overheating and insufficient current account surplus. Region 3: Unemployment and insufficient current account surplus. Region 4: Unemployment and excessive current account surplus.

Figure 12: Policy Response to a Negative Terms-of-Trade Shock



Note. $p^{x\prime} < p^x$.

Region 3, located below the I and X schedules, is characterized by involuntary unemployment and a current account balance below target. And in region 4, located below the I schedule and above the X schedule, the economy suffers unemployment and a current account balance larger than desired.

6.1 Policy Response to Terms-of-Trade Shocks

The Salter-Swan apparatus is useful for ascertaining how the policymaker should react to exogenous disturbances buffeting the economy. Consider the case of a negative terms-of-trade shock, as depicted in Figure 12. The policy stance is originally at point A. The deterioration in the terms of trade shifts the I and X schedules up. The new policy mix that achieves the government objectives is at point B. If the government does not make changes to the exchange-rate or fiscal policy, then, after the shock, point A is in Region 3, where the economy suffers from involuntary unemployment and the current account balance is below target. Moving to point B requires a devaluation, but it is unclear how the fiscal authority should react. The intuition behind this prediction of the model is that the devaluation addresses the two problems faced by the policymaker: It fosters employment in both the traded and nontraded sectors (by reducing real labor costs) and improves the current account (by inducing an increase in tradable output and discouraging consumption of tradables). An expansion in government spending has conflicting effects. On the one hand, it promotes employment, by increasing the demand for nontradables. On the other hand, it worsens the external balance, by expanding domestic absorption. As a result, the fiscal intervention to achieve external and internal balance in response to a terms of trade deterioration can be either positive or negative. We conclude that according to the Salter-Swan framework, a terms-of-trade deterioration calls unambiguously for a nominal depreciation of the domestic currency but does not have a clear prescription for the fiscal policy response.

7 Policy Response to Country-Spread Shocks

Country spread shocks have been shown to be an important driver of the business cycle in small open economies (Neumeyer and Perri, 2005; Uribe and Yue, 2006). An increase in the country spread increases the cost of external funds of the small open economy. Thus, the interest rate r_t is the sum of the world interest rate and the country spread. To analyze the policy response to a temporary increase in the country spread, let r_{ss} be the steady-state interest rate ($t > 0$) and r the interest rate in period 0. Suppose that

$$r > r_{ss}$$

and that

$$\beta(1 + r_{ss}) = 1.$$

With a time-varying interest rate, the household's Euler equation, (4), becomes

$$\left(\frac{c_{t+1}^T}{c_t^T}\right)^{\sigma} = \beta(1 + r_t).$$

Because the interest-rate is constant after period 0, we have that consumption of tradables reaches a steady state in period 1. Let c^T and c_{ss}^T denote consumption of tradables in period 0 and in periods $t > 0$, respectively. Then, the equilibrium conditions are given by equations (11)-(13) and

$$\left(\frac{c_{ss}^T}{c^T}\right)^{\sigma} = \beta(1 + r), \tag{26}$$

$$c^T + \frac{1}{1+r}\frac{1+r_{ss}}{r_{ss}}c_{ss}^T + \gamma g = p^x y^T + \frac{1}{1+r}\frac{1+r_{ss}}{r_{ss}}p_{ss}^x y_{ss}^T, \tag{27}$$

and

$$\frac{A_2(c_{ss}^T, F_N(\bar{h} - h_{ss}^T))}{A_1(c_{ss}^T, F_N(\bar{h} - h_{ss}^T))} = \frac{p_{ss}^x F_T'(h_{ss}^T)}{F_N'(\bar{h} - h_{ss}^T)}, \tag{28}$$

which form a system of six equations in six unknowns, c^T, c^T_{ss}, p, h, h^T, and h^T_{ss}, given predetermined W, and the monetary and fiscal policy choices $\mathcal{E}$ and g, respectively.

By an analysis similar to the one carried out in section 4, it is possible to show that private absorption of tradables is decreasing in the interest rate r, so we can write

$$c^T = C^T(\underset{-}{W/\mathcal{E}}, \underset{-}{\gamma g}, \underset{+}{p^x}, \underset{-}{r}).$$

This, in turn, implies that the D function, given in equation (19), is also decreasing in r,

$$p = D(\underset{-}{h}; \underset{-}{W/\mathcal{E}}, \underset{+}{g}, \underset{+}{p^x}, \underset{-}{r}). \tag{29}$$

By contrast, the S function, given in equation (21), is independent of the interest rate. The Internal Balance equation is then implicitly given by the solution to

$$D(\bar{h}; W/\mathcal{E}, g, p^x, r) = S(\bar{h}; W/\mathcal{E}, p^x).$$

Solving this expression for $\mathcal{E}$ yields

$$\mathcal{E} = I(\underset{-}{g}; \underset{-}{p^x}, \underset{+}{r}).$$

An increase in the interest rate shifts the Internal Balance schedule up and to the right. The reason is that an increase in r depresses domestic absorption, which requires a depreciation of the domestic currency (an increase in $\mathcal{E}$), if full employment is to be restored. The depreciation reduces the real wage, creating incentives for firms to expand employment and output. The depreciation also induces an expenditure switch away from tradables and toward nontradables, which allows firms in the nontraded sector to sell their increased production.

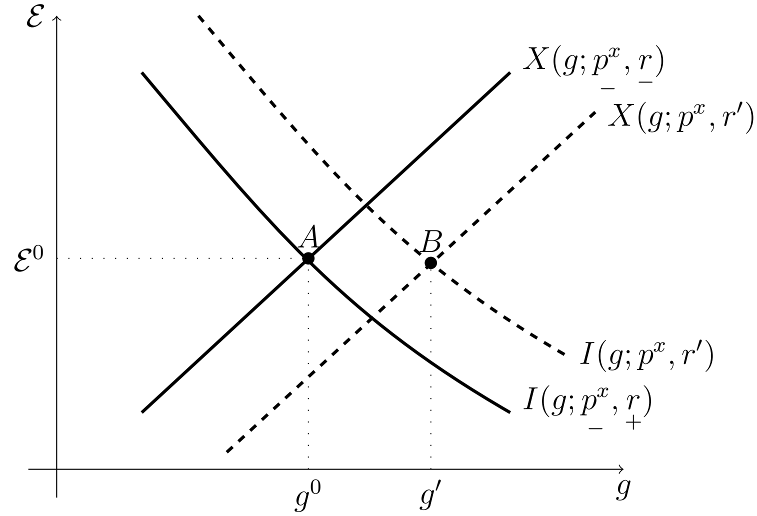
Let's now analyze how the interest rate enters in the External Balance schedule. Because tradable consumption, c^T, is decreasing in the interest rate, and tradable output, y^T, is independent of the interest rate, we have that the current account schedule, ca, is increasing in r. So we can write equation (24) as

$$ca = CA(\underset{+}{\mathcal{E}}, \underset{-}{g}, \underset{+}{p^x}, \underset{+}{r}). \tag{30}$$

Setting the current account to its target level, $\overline{ca}$, and solving for the nominal exchange rate, $\mathcal{E}$, we obtain the External Balance schedule,

$$\mathcal{E} = X(\underset{+}{g}; \underset{-}{p^x}, \underset{-}{r}).$$

Figure 13: Policy Response to an Increase in the Country Spread



Note. $r' > r$.

An increase in the interest rate shifts the External Balance schedule down and to the right. The intuition is that holding constant the exchange rate and government spending, an increase in the interest rate improves the current account, so an appreciation of the exchange rate is required to bring the current account balance down to its target level.

Consider now the effect of an increase in the country spread, which, as mentioned earlier, is equivalent to an increase in the interest rate r. Specifically, suppose that the interest rate increases from r to $r' > r$. Figure 13 illustrates the policy adjustment. The initial position is at point A. As discussed, in response to the increase in the interest rate the Internal Balance schedule shifts up and the External Balance schedule shifts down. Holding policy constant, the increase in r produces a decline in demand and hence unemployment and an increase in the current account balance. Thus, in the absence of a policy response to the increase in the country spread, the economy remains at point A, which is now in Region 4, where the economy suffers involuntary unemployment and an excessive current account surplus. To return the economy to its internal and external targets, given by point B, government spending must increase unambiguously. The intuition is that an increase in g increases employment in the nontraded sector and reduces the current account surplus. By contrast, the response of the exchange rate is ambiguous. The reason is that a depreciation causes conflicting effects on the two target variables, for it fosters employment (a movement in the desired direction), but improves the current account (a movement in the wrong direction).

8 The Salter-Swan Framework Augmented with a Collateral Constraint

An empirically unsatisfactory prediction of the Salter-Swan policy framework is that in response to an increase in the interest rate, the government must increase government spending to prevent the current account surplus from exceeding its ad-hoc target for this variable. The analysis in the present section suggests that a possible solution to this problem is to assume that policymakers do not care equally about current-account deficits and surpluses. It seems empirically reasonable to assume that governments are concerned with current-account deficits, but not so much with current account surpluses. Seldom do we hear of a country suffering from an increase in the external costs of funds announcing a fiscal expansion with the sole aim of reducing a current account surplus.

In this section, we study how exchange-rate policy and fiscal policy adjust in response to external shocks when the government faces asymmetric constraints on its external balance. To this end, we assume that the economy is subject to an external borrowing constraint of the form

$$\frac{d_{t+1}}{1+r} \leq \kappa p_t^x y_t^T,$$

where $\kappa > 0$ is a parameter regulating the stringency of the borrowing limit. The larger κ is, the more the country can borrow. This constraint can be interpreted as a collateral constraint in the spirit of the sudden-stop literature (see, for example, Mendoza, 2002; Uribe, 2006 and 2007; Korinek, 2011; Bianchi, 2011; Benigno et al., 2013 and 2016). Its rationale is that foreign lenders have the ability to seize a fraction κ of the country's exportable output in case of default. So $\kappa p_t^x y_t^T$ is the maximum level of debt supportable without default risk.

As in Uribe (2006, 2007) it is assumed that, although individual agents understand that the constraint exists, they do not internalize it and behave as if they did not face a collateral constraint. The government, however, internalizes the collateral constraint and employs exchange-rate policy and fiscal policy to avoid sudden stops, defined as a situation in which an unexpected negative shock causes the collateral constraint to bind. For analytical convenience, the present version of the collateral constraint is one in which foreign lenders do not observe individual incomes but only the aggregate level of tradable output. As a result, they limit the total amount of credit to the country to a fraction κ of its aggregate tradable output. Also for analytical convenience, we assume that nontradable income cannot be used as collateral. The results presented in this section are robust to relaxing this assumption.

Because we are considering a purely temporary shock in period 0 and the economy reaches a perfect-foresight steady-state in period 1, the collateral constraint is economically relevant only in the initial period. In addition, because the country is assumed to start period 0 with a zero net foreign asset position ($d_0 = 0$), we have that the debt assumed in period 0 equals the negative of the current account, that is, $d/(1+r) = -ca$, where, as before, we drop time subscripts to denote variables determined in period 0. Thus, the collateral constraint can be written as

$$-ca \leq \kappa\, p^x y^T.$$

Using equilibrium condition (30) and the fact that in equilibrium $y^T = F_T\left({F'_T}^{-1}\left(\frac{W/\mathcal{E}}{p^x}\right)\right)$, and rearranging terms, we can write the collateral constraint as

$$CA(\mathcal{E}, g, p^x, r) + \kappa p^x F_T\left({F'_T}^{-1}\left(\frac{W/\mathcal{E}}{p^x}\right)\right) \geq 0.$$

The left-hand side is decreasing in g and increasing in $\mathcal{E}$, p^x, and r. So we can write the collateral constraint compactly as

$$\mathcal{E} \geq X(\underset{+}{g}; \underset{-}{p^x}, \underset{-}{r}) \tag{31}$$

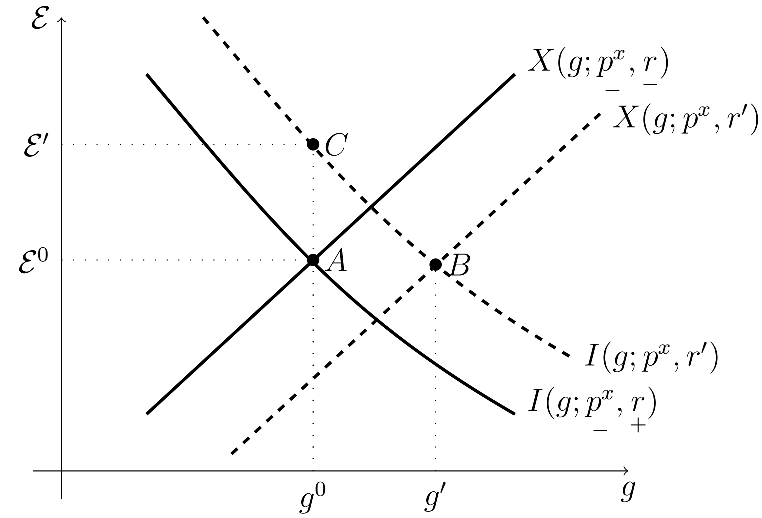
This inequality is the external balance schedule relationship when the country faces a collateral constraint, as opposed to an ad-hoc target for the current account as assumed in the original Salter-Swan framework. Besides the fact that this external balance relationship is microfounded, an important difference is that now the external balance relationship takes the form of an inequality. Any exchange rate, $\mathcal{E}$, above the threshold $X(g; p^x, r)$ is consistent with the satisfaction of the collateral constraint. This implies that the policymaker must change policy when faced with too low current balances but need not intervene when faced with too high current account balances, that is, in the collateral constraint economy the policy maker no longer cares equally about current account deficits and surpluses.

8.1 Policy Response to an Interest Rate Increase

Consider now the policy reaction to an interest-rate increase. Figure 14 analyzes the situation. Suppose that initially the collateral constraint holds with equality, so that the policy mix is at point A in the figure. An increase in the interest rate from r to $r' > r$ causes a shift upward in the Internal Balance schedule, as usual. Also as usual, the schedule $X(g; p^x, r)$ shifts down and to the right.

Holding policy constant (point A), the increase in r improves the current account and leaves tradable output unchanged. Therefore, the collateral constraint, $ca > \kappa p^x y^T$, becomes slack, so the policy reaction is not constrained by external-balance considerations. (Point A

Figure 14: Policy Response to an Increase in the Interest Rate in the Collateral Constrained Economy



Note. $r' > r$.

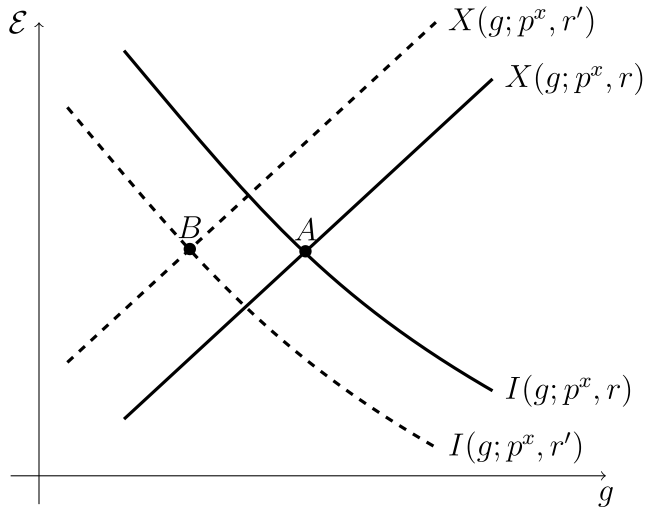
lies above the schedule $X(g; p^r, r')$.) By contrast, at point A internal balance is compromised, as the increase in the interest rate causes unemployment. (Point A lies below $I(g; p^x, r')$.)

The new policy mix must be on the new internal balance schedule and above the schedule $X(g; p^x, r')$. Thus any policy mix on the new internal balance schedule located northwest of point B achieves the objectives of the government. In particular, contrary to what happens when the government has an ad-hoc external balance target ($ca = \overline{ca}$), an increase in government spending is no longer necessary to achieve internal and external balance. The government can restore full employment and satisfy the collateral constraint by depreciating the currency and keeping government spending unchanged (point C in the figure). In this case the purpose of the depreciation (the increase in the exchange rate from $\mathcal{E}^0$ to $\mathcal{E}'$) is not to improve the external accounts but to boost employment by means of a reduction in the purchasing power of wages (which lowers firms' labor costs).

8.2 Policy Response to an Interest Rate Decrease

The policy reaction is asymmetric with respect to increases and decreases in the interest rate. To see this consider a fall in the external cost of funds from r to $r' < r$. This causes the Internal Balance schedule to shift down and the schedule $X(g; p^x, r)$ to shift up as shown in figure 15.

Figure 15: Policy Response to Decrease in the Interest Rate in the Collateral Constrained Economy



Note. $r' < r$.

At the original policy combination, the economy would suffer inflationary pressures and a worsening of the current account, which would make the collateral constraint be violated as point A lies above $I(g; p^x, r')$ and below $X(g; p^x, r')$. The policy combination that achieves the internal and external goals of the government is any point on the new internal balance schedule, $I(g; p^x, r')$, northwest of point B. Thus, the policymaker unambiguously must cut public spending, as it contributes to fending off both overheating and a deterioration of the current account. By contrast, the response of the exchange rate is ambiguous, as it has conflicting external and internal effects. A devaluation would make it possible to increase the current account enough to satisfy the collateral constraint, but doing so would exacerbate the overheating problem.

Summing up, in an economy in which the external balance objective is micro-founded via a collateral constraint, the government need not respond to interest-rate increases with expansionary fiscal policy. Exchange-rate policy by itself can achieve the government's internal and external objectives. By contrast, the government must respond to interest-rate declines with a decisive cut in public spending to avoid overheating.

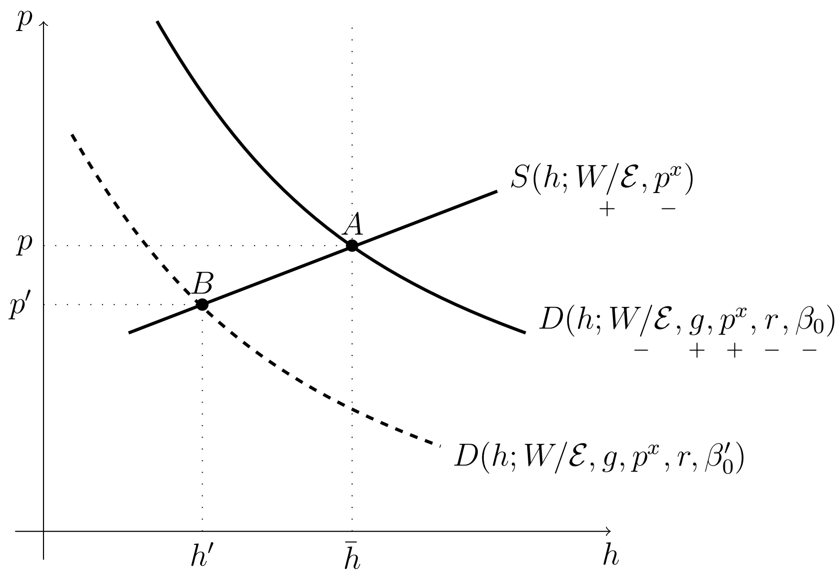
9 A Natural Rate Shock

The main takeaway of section 8, where we microfounded the external balance schedule by means of a collateral constraint, is a reassessment of the role of exchange rate and fiscal policy in bringing about internal and external balance in favor of the former policy instrument. Thus far, we have demonstrated this result in the context of external shocks. In this section, we show that the power of exchange rate policy also holds in the context of domestic shocks.

A domestic demand shock that has gained renewed attention in the past two decades is the natural rate shock in the spirit of Wicksell (1898). A negative natural rate shock induces agents to forego current consumption in favor of future consumption and in this way lowers current demand. We operationalize an adverse natural rate shock by a temporary increase in the subjective discount factor in period 0. Specifically, we assume that in period 0, prior to the shock, the discount factor is equal to $\beta_0 = \beta$. The natural rate shock consists in an increase in the discount factor in period zero from β_0 to $\beta_0' > \beta$. In all other period the discount factor is equal to β. To understand the macroeconomic effects of this domestic demand shock, we initially keep exchange-rate and fiscal policy, that is, $\mathcal{E}$ and g, unchanged.

When β_0 increases, agents become more patient and desired consumption falls in period 0 and increases in future periods. Given the relative price of nontradables in terms of tradables, households wish to reduce the consumption of both tradable and nontradable goods in period 0. The desired reduction in tradable consumption results in an improvement in the trade balance. The desired reduction in nontradable consumption puts downward pressure on the relative price of this good. However, prices have a limited margin to fall because labor cost is unchanged due to downward nominal wage rigidity. As a result the adjustment takes the form of a decline in the quantity of nontradables produced and involuntary unemployment. In sum, absent policy intervention, a negative natural rate shock causes an improvement in the trade balance and involuntary unemployment. The improvement in the trade balance reduces the amount of debt incurred in period 0, thereby loosening the collateral constraint. In other words, the negative natural rate shock does not compromise external balance. On the other hand, the emergence of involuntary unemployment means that the economy has lost internal balance. A depreciation of the nominal exchange rate can restore internal balance by lowering the real wage and thereby fostering employment in both the tradable and nontradable sectors. In addition, the depreciation of the domestic currency does not undermine the external objectives of the government. On the contrary, it improves the trade balance by boosting the production of tradable goods. Thus, an exchange rate intervention consisting in depreciating the domestic currency suffices to restore internal and external balance after a negative natural rate shock.

Figure 16: Equilibrium Effects of a Temporary Negative Natural Rate Shock on Employment and the Real Exchange Rate



Note. $\beta_0' > \beta_0$.

More formally, one can show that the demand schedule D, given in equation (29), depends negatively on the discount factor in period 0, β_0,

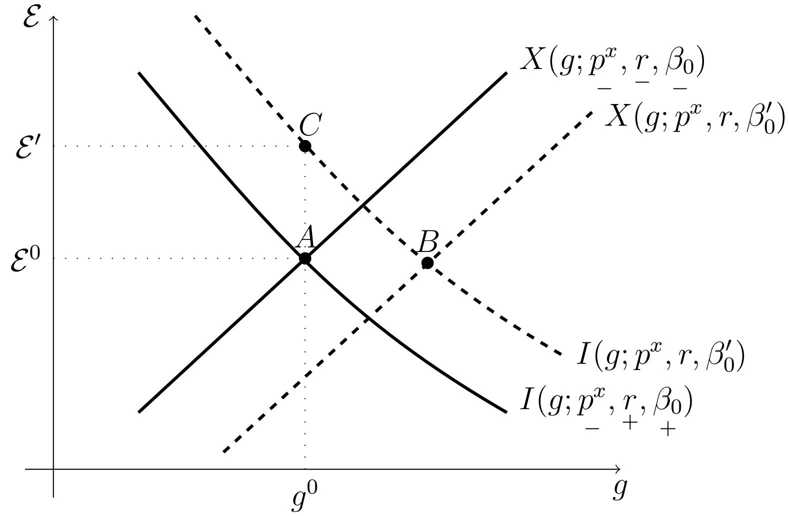
$$p = D(\underset{-}{h}; \underset{-}{W/\mathcal{E}}, \underset{+}{g}, \underset{+}{p^x}, \underset{-}{r}, \underset{-}{\beta_0}).$$

The negative sign underneath the discount factor β_0 reflects the downward pressure on the relative price of nontradables resulting from the reduction in the desired demand for goods as households become more patient in period 0. It can also be shown that the supply schedule, S, does not depend on the discount factor β_0 and continues to be given by equation (21), which we reproduce here

$$p = S(\underset{+}{h}; \underset{+}{W/\mathcal{E}}, \underset{-}{p^x}).$$

Figure 16 depicts the effect of a negative natural rate shock, an increase in the subjective discount factor from β_0 to $\beta_0' > \beta_0$, on employment and the real exchange rate in the absence of government intervention. Prior to the shock, the economy is at point A, where the labor market operates at full employment, $h = \bar{h}$. The increase in the subjective discount factor shifts the demand schedule down and to the left. The supply schedule is unchanged. The new equilibrium is at point B and features involuntary unemployment in the amount $\bar{h} - h'$

Figure 17: Effect of a Negative Natural Rate Shock on Internal and External Balance



Note. $\beta_0' > \beta_0$.

and a depreciation of the real exchange rate from p to $p' < p$.

The government can restore full employment by either devaluing the domestic currency (increasing $\mathcal{E}$) or by a fiscal expansion (increasing g). A devaluation shifts the supply schedule down and to the right (through a reduction in real labor costs) and the demand schedule up and to the right. A fiscal expansion leaves the supply schedule unchanged and shifts the demand schedule up and to the right. This means that a negative natural rate shock shifts the internal balance schedule up and to the right, as shown in figure 17.

It can also be shown that the negative natural rate shock causes the trade balance and hence the current account to improve in period 0. As discussed earlier, this effect is driven primarily by a contraction in domestic absorption as households become more patient. Thus we have the following current account schedule

$$ca = CA(\underset{+}{\mathcal{E}}, \underset{-}{g}, \underset{+}{p^x}, \underset{+}{r}, \underset{+}{\beta_0}).$$

The collateral constraint introduced in section 8 then takes the form

$$CA(\mathcal{E}, g, p^x, r, \beta_0) + \kappa p^x y^T \geq 0.$$

Tradable output in period 0, y^T, is unaffected by the natural rate shock. Thus, in response to an increase in β_0, the government can maintain the same slack in the collateral constraint by either appreciating the domestic currency or expanding public spending. This gives rise to the following external balance condition

$$\mathcal{E} \geq X(\underset{+}{g}; \underset{-}{p^x}, \underset{-}{r}, \underset{-}{\beta_0}).$$

Figure 17 depicts with a solid upward sloping line the pairs $(\mathcal{E}, g)$ that guarantee that the collateral constraint is satisfied with equality when the discount factor is equal to β_0, that is, prior to the natural rate shock. An increase in the discount factor from β_0 to $\beta_0' > \beta_0$, shifts this schedule down and to the right as shown with the broken upward sloping line. Suppose that before the shock the policy mix is at point A, where the economy enjoys full employment and the collateral constraint is satisfied with equality. In the absence of a policy change, the negative natural rate shock generates unemployment. This can be seen by the fact that point A lies below the new internal balance schedule (the downward sloping broken line). The collateral constraint, which prior to the shock was holding with equality, is now slack. This can be seen from the fact that point A lies above the upward sloping broken line. Thus the only problem that the negative natural rate shock presents to the policy maker is internal imbalance in the form of unemployment. This problem can be addressed with a depreciation of the exchange rate and does not require a fiscal expansion. Specifically, an increase in the exchange rate from $\mathcal{E}^o$ to $\mathcal{E}'$, which brings the policy mix from point A to point C, located directly above point A, restores full employment and maintains external balance (in fact, it widens the slack in the collateral constraint). Of course, there also exist other policy combinations that restore full employment and guarantee the satisfaction of the collateral constraint. In particular, any pair $(g, \mathcal{E})$ on the new internal balance schedule (the downward sloping broken line) and to the left of point B is consistent with internal and external balance.

10 Discussion and Conclusion

A central distinction between the Salter-Swan policy framework and more recent approaches to stabilization policy has to do with the assumed government objectives. In the Salter-Swan framework, the government has targets for aggregate activity and the current account. Accordingly, the fulfillment of these two objectives requires the use of two policy instruments (Tinbergen, 1952), which in this particular framework are the nominal exchange rate and government spending. In this context, government spending is a useful instrument even under the assumption that it is fully unproductive. This property is rooted in a classical Keynesian tradition.

By contrast, in more recent theories of stabilization policy the government is assumed to have a single objective, namely, the maximization of the lifetime welfare of households. This assumption can give rise to opposite results from those implied by the Salter-Swan framework, especially for the role of public spending. Specifically, it can be shown that in the model studied in this paper, full employment at all times is optimal. Further, since the economy possesses a single distortion taking the form of downward nominal wage rigidity, exchange rate management suffices to bring about full employment. Thus, if government spending is unproductive, it becomes optimal for the government to set it equal to zero at all times. Even if government spending was assumed to be productive—e.g., by entering in the utility function or as an efficiency factor in the firm's production technology—its determination would not be connected to achieving a target level of the current account, and therefore will in general have different cyclical properties than those implied by the microfounded Salter-Swan policy framework developed in the present paper.

An important role of any theoretical policy framework is to communicate the workings of the economy, and, in particular, the economic consequences of policy interventions, to policymakers. If the policymaker's preoccupations regarding macroeconomic stability are limited to unemployment and the price level, then the welfare-based framework is the most effective way of communication. This is because, as shown by Woodford (2003), there is a mapping between the representative household's lifetime utility function and a traditional loss function that includes the output gap and inflation. However, if, as is typically the case in small open economies, the government is also concerned with the evolution of the current account, the Salter-Swan framework, which explicitly takes into account targets for this variable, in addition to the traditional inflation-unemployment tradeoff, is likely to provide a more effective means of communication.

The original Salter-Swan framework takes as given that the policy maker has an exogenous target for the current account. We show that this assumption is problematic as it produces the counter-factual prediction that in response to an adverse country spread shock the government must expand fiscal policy not because it is indispensable to ensure full employment but because it is the only way to avoid too large a current account surplus. A contribution of the present paper, above and beyond providing micro-foundations for the Salter-Swan framework, is to integrate it with the modern sudden stop literature to endogenize the current account target. This task was achieved by introducing a collateral constraint whereby external debt is limited by a fraction of aggregate output. The integrated model fixes a fundamental problem of the Salter-Swan framework as a fiscal expansion ceases to be necessary to achieve the country's external objectives in response to an adverse country spread shock.

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