Step away from the zero lower bound:
Small open economies in a world of secular stagnation

Giancarlo Corsetti, Eleonora Mavroeidi, Gregory Thwaites, and Martin Wolf[*]

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Abstract

We study how small open economies can escape from deflation and unemployment in a situation where the world economy is permanently depressed. Building on the framework of Eggertsson et al. (2016), we show that the transition to full employment and at-target inflation requires real and nominal depreciation of the exchange rate. However, because of adverse income and valuation effects from real depreciation, the escape can be *beggar thy self*, raising employment but actually lowering welfare. We show that as long as the economy remains financially open, domestic asset supply policies or reducing the effective lower bound on policy rates may be ineffective or even counterproductive. However, closing domestic capital markets does not necessarily enhance the monetary authorities' ability to rescue the economy from stagnation.

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JEL-Codes:	F41, E62

1 Introduction

Real interest rates fell to historic lows around the industrialised world in the two decades prior to the Global Financial Crisis of 2008, and fell even further thereafter. Unemployment rose during the crisis, and remains high in several major economies. Observers have labelled this 'secular stagnation' (Summers (2013), echoing Hansen (1938)) and interpreted it as the result of a durable, possibly permanent fall in the natural interest rate, to levels too low to be attained with existing inflation targets, hence giving rise to chronic unemployment (Eggertsson and Mehrotra (2014)). In the leading interpretation, secular stagnation is the result of an 'asset shortage': because of financial distortions in the form of credit constraint on economic agents with the high marginal propensity to spend, the desired savings of the economy at full employment cannot be absorbed by the stores of value available in the domestic economy at positive interest rates.[1]

In this paper, we study the implications of global secular stagnation for the macroeconomic dynamics and policy trade-offs in a small open economy integrated in the world goods and financial markets. Open economies can in principle alleviate asset shortage by acquiring foreign assets and depreciating their currencies. Eggertsson et al. (2016) (henceforth EMSS) and Caballero et al. (2015) (henceforth CFG) study a global equilibrium in which the negative spillovers from such developments can actually spread secular stagnation worldwide. Complementing these analyses, we study the domestic equilibrium and issues in economic stabilization of a country that simultaneously faces weak external demand due to the global slump and, as long as it remains financially open, an inefficiently high real interest rate, pinned down by the equilibrium conditions in the international capital markets. To carry out our analysis, we build an overlapping-generations framework that combines the features stressed by EMSS and CFG, and specify an economy that has some monopoly power over its terms of trade, but is otherwise small enough not to affect the policy behaviour and the macroeconomic equilibrium in the rest of the world.

Our main contributions are as follows. First, we show that under plausible conditions a small open economy in a world of chronic deflation and deficient demand can be in either of two disjoint steady-state equilibria—an underemployment steady state symmetric to the rest of the world, and a full-employment equilibrium with inflation at target, trend nominal depreciation, a permanently weaker real exchange and the accumulation of net foreign assets. In the full-employment equilibrium, trend nominal depreciation is required to insulate domestic

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[1]To the extent that the domestic monetary policy framework is unable to accommodate the fall in the real interest rate required to bring supply and demand for assets back into line when the economy operates at full employment, the margin of adjustment becomes a reduction in output.

inflation from the deflationary drift abroad (associated to the global secular stagnation). A depreciated real exchange rate is required to maintain a high foreign demand for domestic output and support full employment. Accumulation of net foreign assets is required to absorb higher national savings, to the extent that these are generated by income and balance sheet effects from escaping secular stagnation.

Second, we show that welfare gains and losses from escaping secular stagnation are not evenly distributed across different stages in each generation and, most strikingly, social welfare may not rise overall. This is because, for given terms of trade, domestic incomes and lifetime utilities rise with increasing output. Yet, for a given output path, real depreciation reduces incomes in real terms and may exacerbate the financial constraints in the economy—in our baseline, these constraints limit the ability of the young generation to borrow and consume in anticipation of future income, whose value falls with real depreciation.[2] Specifically, we show that the adverse income effects of real depreciation dominate social welfare for relatively low yet standard trade elasticities: as an increasing external demand for domestic goods contributes to closing the domestic output and employment gaps, national consumption and lifetime utilities actually fall.[3] Currency wars, in this context, can be *beggar thy self*, rather than *beggar thy neighbor*.[4]

Third, we characterize the macroeconomic dynamics along the transition from the underemployment to the full employment equilibrium. Since bringing the economy to full employment entails an increase in domestic inflation relative to the rest of the world, it follows that the nominal exchange rate must steadily depreciate—an echo of Svensson's 'Foolproof Method'

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[2]In the case in which lifetime utilities rise when moving from secular stagnation to the full-employment equilibrium, in each generation losses when young are more than compensated by gains when middle-aged or old.

[3]A distinctive feature of our contribution is our focus on an open economy that, while small, produces a differentiated domestic good. We are thus able to provide an account of the real exchange rate, and analyze the role of substitution and income effects in shaping the transition from secular stagnation to a full-employment steady state. In a closed economy context, along this transition, higher employment and output prospects produce a positive income effect that boosts demand at each point in time—the real interest rates may actually rise without offsetting the increase in demand. In open economy, however, a country moving towards full employment must experience domestic real depreciation, for world demand to absorb the rising volume of domestic output—a substitution effect. But a falling price of domestic output also reduces domestic purchasing power—producing a negative income effect. When domestic and foreign goods are sufficiently substitutable, this negative income effect are small: despite the adverse terms of trade movement, a higher volume of domestic output increases domestic income. In this case, domestic households must acquire foreign assets in order to absorb the increased savings that result from full employment. Along the transition, the country runs an external surplus. In contrast, when domestic and foreign goods are poor substitutes, the price of home goods must fall by a larger amount to create enough demand for home output at full employment. This fall in prices can outweigh the increase in output volume, leaving domestic households poorer notwithstanding the gains in employment. Home residents work more but consume less—which raises the possibility of welfare losses.

[4]Welfare assessment crucially depends on the disutility from involuntary unemployment, a point recently stressed by Schmitt-Grohé and Uribe (2016). For an analysis of beggar thyself depreciation in open economy macro see Corsetti and Pesenti (2001).

(Svensson (2001))—and therefore that escape is not possible without exchange rate flexibility. However, capital mobility means that the real interest rate is pinned down in international bond markets, and hence is the same (and too high) in both the stagnation *and* the full employment equilibrium. This is in contrast to a typical New Keynesian account of business-cycle stabilisation, in which policy makers must set the real interest rate at its 'natural' level to achieve full employment.[5]

Fourth, we show that, as long as the natural rate of interest is sufficiently negative, closing the economy financially and hence barring the possibility to accumulate foreign assets, eliminates the full-employment steady state: in financial autarky, there is no equilibrium in which the increase in external demand following real depreciation is sufficient to rebalance the secular stagnation distortions. This result obtains despite the fact that, under financial autarky, domestic policy makers regain control over domestic real interest rates, which are no longer determined in international bond markets via international asset arbitrage. Hence, this result provides an instructive caveat on the desirability of capital controls as a way to regain monetary policy effectiveness.[6]

In light of this result, we reconsider a number of other policies which can alleviate secular stagnation under financial autarky. Barring trade in assets, policies that relax the borrowing constraint on the young raise the natural rate, with the effect of moderating the excess-savings problem of the country. Under financial integration, we show that the same policies are neutral in terms of domestic output and inflation—again, because real rates are not sensitive to domestic savings imbalances, but determined internationally. Moreover, to the extent that these policies raise the saving-absorption capacity of the economy, they lead to capital inflows, and thus to lower external surpluses and a weaker real exchange rate. By the logic of the "transfer problem" in international economics (after Keynes (1929)), aggregate consumption falls, detrimental to national welfare. Hence, under financial integration, asset supply policies turn out to be *beggar thy self*.

Similar considerations apply to policies attempting to counter low inflation and/or lacklustre

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[5]The transition path to full employment is different from the escape from liquidity traps in the standard New-Keynesian models. As expectations shift to the full employment equilibrium, the real exchange rate tends immediately to fall towards its new equilibrium level. This switches demand to the home economy, but output cannot grow too quickly without compromising the inflation target. So, the central bank temporarily *raises* real and nominal interest rates to control the depreciation of the exchange rate and prevent an overshoot of the inflation target. In an extension of our model, however, we show that the zero lower bound may temporarily be a problem if trade volumes are initially slow to respond. In this case, the exchange rate overshoots its long run level on impact, and the nominal interest rate remains temporarily stuck at the zero lower bound. Correspondingly, the real interest rate temporarily needs to fall.

[6]To provide insight on the role of balance sheet effects of depreciation in driving net foreign asset accumulation, in an extension of the model, we explore the implication of a different specification of the borrowing constraint on the young.

growth by relaxing the effective lower bound (ELB) on nominal rates (the Danmarks Nationalbank (DN), the European Central Bank (ECB), the Sveriges Riksbank and the Swiss National Bank (SNB) all cut interest rates to below zero during the period from mid-2014 to early 2015, and most recently the Bank of Japan (BoJ) (see Bech and Malkhozov (2016)) and BoE[7] applied similar policies). We show that, in financially integrated small open economies, this policy is generally not beneficial to welfare. The kernel of the intuition is simply that, when real rates are determined internationally, lower nominal rates must eventually entail trend exchange rate appreciation, lower inflation, and thereby a more negative output gap. However, we also show that, should the ELB become binding *along the escape path*, relaxing it can help to shorten the transition to full employment.

Finally, we provide empirical evidence consistent with our model's core prediction: that higher net foreign assets and real depreciation are associated with higher employment—and this more so when the world economy is in a global recession. In a global secular stagnation, with the world economy underemployed on average, the distribution of global output depends on who owns the scarce stores of value traded internationally. According to our baseline model specification, measures of resource utilisation will be an increasing function of an economy's net foreign assets. We test and verify this prediction in a cross-country panel regression of unemployment or the ouptut gap on net foreign assets, interacting its coefficient with the world average employment rate. While these correlations are consistent with a range of explanations, they are also borne out by our model.

Two of many points of contact with the literature are worth highlighting here. Firstly, in line with the recent literature reviving secular stagnation, our paper focuses on the case where the world is *permanently* in a liquidity trap with negative neutral rates. Yet, our analysis naturally relates to contributions that study open economies in a *temporary* liquidity trap, either using a two-country model, see Cook and Devereux (2013), or taking the perspective of a small open economy, see Corsetti et al. (2016). Exchange rate adjustment is key in both these studies and the present one to moderate the negative implications of a global liquidity trap for the domestic economy. In particular, the nominal exchange rate needs to depreciate persistently to allow domestic inflation to rise above the world deflationary drift. But in contrast to our analysis, however, in these frameworks the domestic real rate must fall to boost demand.

Secondly, as we focus on a small open economy, we do not discuss the cross-border spillovers that may stem from different domestic adjustment paths —amply discussed by Eggertsson et al. (2016) and Caballero et al. (2015) in their two-country frameworks. By no means do we

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[7]Monetary Policy Summary, 4 August 2016, http://www.bankofengland.co.uk/publications/minutes/Documents /mpc/mps/2016/mpsaug.pdf

intend to downplay these issues. In particular, if a sufficient number of small open economies pursue the escape path depreciating their currencies, their joint behaviour is likely to have a first-order effect on the world real interest rate and allocation. In this case, domestic policymakers might need to focus on domestic stimulus rather than relying solely on the exchange rate channel, while support from other policies, including structural policies and asset-supply policies, might be necessary to lift global neutral rates. It is precisely because each small country has a strong incentive to pursue an individual escape path from stagnation that international policy coordination may be required.

The remainder of this paper is organised as follows. Section 2 outlines the two-country model used in our analysis. Section 3 establishes that a full-employment steady state exists under financial integration. Section 4 discusses the possibility of beggar-thy-self depreciation. Section 5 studies how the economy escapes from the secular stagnation. Sections 6 and 7 discuss, respectively, asset supply policies and alternative monetary policy measures. Section 8 presents empirical evidence consistent with the predictions of our model. Section 9 concludes. The appendix includes proofs as well as model extensions and robustness analysis.

2 A model of a small open economy in a global depression

We consider a model of a small open economy under perfect foresight, integrated with the rest of the world (ROW) in both goods and asset markets. The framework is one of overlapping generations (OLG), as in Eggertsson and Mehrotra (2014) and Eggertsson et al. (2015). Each country specializes in the production of one good, but consumes both goods. With home bias in demand, this leads to fluctuations in the terms of trade and the real exchange rate. Furthermore, international asset markets are incomplete, and we assume that each country saves in terms of a CPI-indexed bond. In each country, households live for three periods: young, middle-aged, and old. All the income accrues to the middle aged, such that the young borrow to be able to consume subject to a borrowing constraint, whereas the old consume their savings from last period. Labour supply is exogenous, and wages are assumed to be downwardly sticky.

2.1 Households

Domestic households maximize

$$\max_{\{C_t^y, C_{t+1}^m, C_{t+2}^o\}} \left\{ \frac{(C_t^y)^{1-\rho}}{1-\rho} + \beta \frac{(C_{t+1}^m)^{1-\rho}}{1-\rho} + \beta^2 \frac{(C_{t+2}^o)^{1-\rho}}{1-\rho} \right\} \tag{1}$$

subject to

$$C_t^y = -B_t^y$$

$$C_{t+1}^m = P_{H,t+1}/P_{t+1}Y_{t+1} + (1+r_t)B_t^y - B_{t+1}^m$$

$$C_{t+2}^o = (1+r_{t+1})B_{t+1}^m$$

$$-(1+r_t)B_t^y \leq D_t P_{H,t+1}/P_{t+1}.$$

Here, P_t is the consumer price index (CPI—the price of domestic consumption), $P_{H,t}$ is the producer price index (PPI—the price of domestic output), r_t is the (domestic consumption-based) real interest rate, and D_t is the borrowing constraint faced by the young. Furthermore, $C_t^i, i \in \{y,m,o\}$, represent consumption by the young, middle-aged, and old, respectively, and $B_t^i, i \in \{y,m\}$ are bond holdings/savings by the young and middle-aged, respectively. Finally, $0 < \beta < 1$ denotes the time-preference rate, and $\rho^{-1} > 0$ denotes the intertemporal elasticity of substitution. We consider an equilibrium in which the young borrow all the way up their borrowing constraint

$$C_t^y = -B_t^y = \frac{D_t}{1+r_t}\frac{P_{H,t+1}}{P_{t+1}}. \tag{2}$$

Note that a rise in the CPI relative to the price of domestic income makes the young more borrowing constrained, given that the borrowing limit is denoted in PPI terms while the assets are denoted in CPI terms. Intuitively, the borrowing limit is defined in PPI terms because the collateral against which the young would borrow (the output they will produce when middle aged) is denoted in PPI terms. In the Appedix A.4, we discuss the variant of the model where the borrowing limit is also defined in CPI terms.

The middle-aged satisfy an Euler equation

$$(C_t^m)^{-\rho} = \beta(1+r_t)(C_{t+1}^o)^{-\rho}$$

while the old consume all their savings from last period

$$C_t^o = (1+r_{t-1})B_{t-1}^m.$$

By combining these equations, we obtain the equilibrium consumption of the middle-aged

$$C_t^m = \left(1 - \frac{1}{1 + [\beta(1+r_t)^{1-\rho}]^{-\frac{1}{\rho}}}\right)\left[\frac{P_{H,t}}{P_t}Y_t - \frac{P_{H,t}}{P_t}D_{t-1}\right]$$

and the old

$$C_t^o = (1+r_{t-1})\left(\frac{1}{1 + [\beta(1+r_{t-1})^{1-\rho}]^{-\frac{1}{\rho}}}\right)\left[\frac{P_{H,t-1}}{P_{t-1}}Y_{t-1} - \frac{P_{H,t-1}}{P_{t-1}}D_{t-2}\right].$$

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The savings of the middle-age generation

$$B_t^m = \frac{1}{1 + [\beta(1+r_t)^{1-\rho}]^{-\frac{1}{\rho}}} \left[\frac{P_{H,t}}{P_t} Y_t - \frac{P_{H,t}}{P_t} D_t \right] \tag{3}$$

coincide with the gross savings of the economy.

2.2 Goods market integration

We assume the domestic consumption basket is made up of domestically-produced and ROW-produced goods as follows

$$C_t^i = \left[(1-\omega)(C_{H,t}^i)^{\frac{\sigma-1}{\sigma}} + \omega(C_{F,t}^i)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \quad i \in \{y, m, o\},$$

where $C_{H,t}$ is demand for the domestically-produced, $C_{F,t}$ demand for the ROW-produced good, and where $0 \leq 1 - \omega \leq 1$ is the degree of home-bias in consumption and $\sigma > 0$ the intratemporal elasticity of substitution. Expenditure minimization leeds to a relationship between consumer and producer price indexes as follows

$$P_t = [(1-\omega)(P_{H,t})^{1-\sigma} + \omega(P_{F,t})^{1-\sigma}]^{\frac{1}{1-\sigma}}, \tag{4}$$

where $P_{F,t}$ is the price of the ROW-produced good (expressed in terms of domestic currency). We assume the law of one price holds at the level of each good

$$P_{H,t} = \mathcal{E}_t P_{H,t}^* \quad P_{F,t} = \mathcal{E}_t P_{F,t}^*,$$

where $\mathcal{E}_t$ is the nominal exchange rate (the price of foreign currency in terms of domestic currency) and where an asterisk indicates variables in the ROW (here: the price of the domestic and the ROW-produced good, expressed in terms of foreign currency). Then, the domestic terms of trade (the price of imports in terms of exports) are given by

$$S_t = \frac{P_{F,t}}{P_{H,t}}, \tag{5}$$

and the real exchange rate (the price of ROW-consumption in terms of domestic consumption) obtains from

$$Q_t = \frac{\mathcal{E}_t P_t^*}{P_t}. \tag{6}$$

2.3 Asset market integration

We assume that households can, in addition to their saving in terms of CPI-denominated bonds, also save in non-indexed bonds which pay in terms of local currency. As a result, the Fisher equation (relating real and nominal returns) must hold, that is,

$$(1 + r_t) = (1 + i_t) \frac{P_t}{P_{t+1}}, \tag{7}$$

where i_t is the domestic nominal interest rate. These bonds are in zero net supply, such that we may ignore them in the household problem above. In addition, in a financially integrated economy, households can also save in non-indexed bonds in terms of foreign currency. Hence we need to keep track explicitly of the no-arbitrage condition in international asset markets

$$(1 + i_t) = (1 + i_t^*)\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \tag{8}$$

where i_t^* denotes the foreign nominal interest rate. This is just the uncovered interest parity (UIP) condition.

2.4 Firms and labor market

Output is produced using labour from residents of the respective country, according to

$$Y_t = L_t^\alpha, \tag{9}$$

where $0 < \alpha \leq 1$. Optimality requires $W_t = P_{H,t}\alpha L_t^{\alpha-1}$. Moreover, we adopt the specification in Eggertsson and Mehrotra (2014) and assume that nominal wages are downwardly sticky of degree $0 \leq \gamma \leq 1$:

$$W_t = \max\{\tilde{W}_t, W_t^{flex}\}, \tag{10}$$

where $W_t^{flex} \equiv P_{H,t}\alpha(L^f)^{\alpha-1}$ (here, $L^f > 0$ denotes full employment), and $\tilde{W}_t$ is a wage norm which solves

$$\tilde{W}_t = \gamma W_{t-1} + (1 - \gamma)W_t^{flex}.$$

2.5 Market clearing

Because the domestic economy is small, the CPI in ROW will correspond to the price of foreign output, $P_t^* = P_{F,t}^*$, from which follows

$$Q_t = \frac{P_t^*\mathcal{E}_t}{P_t} = \frac{P_{F,t}}{P_t} = S_t\frac{P_{H,t}}{P_t}. \tag{11}$$

Domestic goods market clearing is then given by

$$Y_t = (1 - \omega)\left(\frac{P_t}{P_{H,t}}\right)^\sigma C_t + \omega S_t^\sigma Y_t^*, \tag{12}$$

where $C_t := C_t^y + C_t^m + C_t^o$ denotes aggregate domestic consumption. Furthermore, asset market clearing requires

$$NFA_t = -\frac{D_t}{1 + r_t}\frac{P_{H,t+1}}{P_{t+1}} + \frac{1}{1 + [\beta(1 + r_t)^{1-\rho}]^{-\frac{1}{\rho}}}\left[\frac{P_{H,t}}{P_t}Y_t - \frac{P_{H,t}}{P_t}D_{t-1}\right], \tag{13}$$

where NFA_t is the domestic country's net foreign asset position. In each period, this is the difference between the saving of the middle-aged generation (net of the payment of their debt to the old) and the consumption of the young. From the households' budget constraint, the flow budget of the domestic country is

$$C_t + NFA_t = (1 + r_{t-1})NFA_{t-1} + \frac{P_{H,t}}{P_t}Y_t. \tag{14}$$

2.6 Phillips Curve and Monetary policy

As in Eggertsson and Mehrotra (2014), we use the production function (9) together with the wage norm (10), to derive a Phillips curve of the form

$$Y_t = \left[\gamma \frac{Y_{t-1}^{\frac{\alpha-1}{\alpha}}}{\Pi_{H,t}} + (1 - \gamma)(Y^f)^{\frac{\alpha-1}{\alpha}} \right]^{\frac{\alpha}{\alpha-1}} \tag{15}$$

whenever $\Pi_{H,t}$ $(:= P_{H,t}/P_{H,t-1}) < (Y^f/Y_{t-1})^{\frac{1-\alpha}{\alpha}}$, and

$$Y_t = Y^f \tag{16}$$

else, where $Y^f = (L^f)^\alpha$ is output under full employment. Note that the Phillips curve is a function of current, not expected inflation.

We posit that the monetary authorities target inflation subject to a zero-bound constraint on nominal rates:

$$\Pi_{H,t} = \bar{\Pi} \quad \text{subject to} \quad i_t \geq 0, \tag{17}$$

If inflation falls below target, nominal rates fall to zero:

$$i_t = 0 \quad \text{if} \quad \Pi_{H,t} < \bar{\Pi}. \tag{18}$$

So, once the economy is in a stagnation steady state and policy rates are at the zero lower bound, nominal interest rates are inelastic to current as well as target inflation: a change in the inflation target per se does not affect agents expectations about the current and future monetary stance.

2.7 Rest of the world and equilibrium at global level

In modelling the rest of the world (ROW), we assume symmetry in economic structure with the small open economy, except for size and policy parameters.

Assumption 1. *The small open economy and the rest of the world have the same degree of risk aversion, time preference, inflation target, curvature of the production function, full-employment (per capita) output and degree of downward stickiness. Also we set $D_t^* = D_t$.*

Since the domestic economy is small, the rest of the world effectively is a closed economy, so we can draw on the main results by Eggertsson and Mehrotra (2014). Specifically, we posit that D^*, the borrowing limit imposed on the young, is sufficiently tight that the ROW is in a secular stagnation steady state. Inflation and output (Π^*, Y^*) then jointly solve

$$D^* \Pi^* = \left(\frac{1}{1 + [\beta(\Pi^*)^{-(1-\rho)}]^{-\frac{1}{\rho}}} \right) [Y^* - D^*] \qquad (19)$$

as well as

$$Y^* = (Y^f)^* \left(\frac{1 - \gamma^*/\Pi^*}{1 - \gamma^*} \right)^{\frac{\alpha}{1-\alpha}}, \qquad (20)$$

where we have used the fact that $i^* = 0$ such that $(1+r^*) = (\Pi^*)^{-1}$, i.e. the ROW counterpart of Fisher equation (7). It is easy to show that, in this steady state, both $\Pi^* < 1$ and $Y^* < (Y^f)^*$ and therefore

$$(1 + r^*) = (\Pi^*)^{-1} > 1. \qquad (21)$$

Hence, in a secular stagnation, the market rate is positive and therefore higher than the *natural* real interest rate. The latter is the real interest that would prevail absent nominal rigidities, and is implicitly defined by

$$\frac{D^*}{1 + (r_{\text{nat}})^*} = \left(\frac{1}{1 + [\beta(1 + (r_{\text{nat}})^*)^{1-\rho}]^{-\frac{1}{\rho}}} \right) \left[(Y^f)^* - D^* \right].$$

The mechanism by which the economy is in stagnation is the same in the analysis by Eggertsson and Mehrotra (2014) and Eggertsson et al. (2015). It is worth going through it, if only briefly, before delving in our study. At the core of the problem is a tight budget constraint D^* for the young that drives down the natural real rate clearing the market for saving by the middle-aged, possibly to negative territory. Despite nominal wage rigidities, this would not be a problem if expected inflation and the domestic inflation target were high enough. The central bank could set a non-negative nominal rate sufficiently low for the bond market to clear at the natural rate. That is to say, a tight constraint D^* and nominal wage rigidities are not sufficient to raise the risk of long-run output gaps—they are sufficient only, if the central bank is not willing to accept the high enough inflation target. Yet, even in this case, markets may coordinate expectations on a low, possibly negative, rate of inflation, causing nominal policy rates (under the rules (17) and (18)) to be constrained at their zero lower bound. In this equilibrium, the monetary stance is endogenously contractionary, causing the output gap to remain open on a permanent basis, and therefore validating the adverse private sector expectations.[8]

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[8]It is worth stressing that prices are fully flexible. With competitive firms, they are equal to marginal

2.8 Equilibrium definition for the small open economy

Given initial conditions $\{Y_{-1}, NFA_{-1}, P^*_{-1}, P_{-1}, P_{H,-1}\}$ and for given variables in the rest of the world $\{D^*, r^*, Y^*, \Pi^*, P^*_t = \Pi^* P^*_{t-1}, i^* = 0\}$, an equilibrium in the domestic economy is a set of sequences $\{C_t, Y_t, Q_t, S_t, P_{H,t}, P_{F,t}, P_t, \Pi_{H,t}, \Pi_t, \mathcal{E}_t, i_t, r_t, NFA_t, D_t\}$ that solve equations (4)-(5),(7)-(14), equations $\Pi_{H,t} \equiv P_{H,t}/P_{H,t-1}$ and $\Pi_t \equiv P_t/P_{t-1}$, equation $D_t = D^*$, and the policy rule (17)-(18).

Throughout the paper, we will posit that the small open economy faces a global secular stagnation, a situation in which all its trading partners are permanently trapped in an equilibrium with deflation, zero nominal interest rates, and inefficient output gaps. From the perspective of the domestic economy, this means stagnating external demand, and inefficiently high real rates, via the equilibrium conditions in the international bond markets. We will explore how a small open economy can cope with this situation, first looking at its steady states, then at the transition dynamics.

3 A full employment steady state

In our baseline specification, the two countries have symmetric features as regards frictions and potential output, as well as policy parameters (e.g. the inflation target). Given that the borrowing constraint $D_t = D^*_t$ is symmetrically tight, when the ROW is in a secular stagnation steady state, there exists a steady state in which the small open economy is also in stagnation. But, as the following proposition states, with integrated world goods and bond markets, such an equilibrium for the home economy is not unique. There is also a second steady state, characterized by full employment, inflation on target, and a strictly positive nominal interest rate.

Proposition 1. *The small open economy specified above can find itself in one of two steady states. The stagnation steady state is characterized by purchasing power parity $Q = S = 1$ and zero net foreign assets $NFA = 0$. Conversely, the full employment steady state has $Y = Y^f$, inflation on target, $(1 + i) = \bar{\Pi}/\Pi^* > 1$, and is associated with a trend nominal depreciation, permanently depreciated real exchange rates, $Q > 1$ and $S > 1$, and a positive stock of net foreign assets $NFA > 0$.*

Proof. See the Appendix A.2. □

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costs—firms are on their labor demand schedule. With nominal wage rigidities, however, workers are not necessarily on their (vertical) labor supply. An insufficient demand in the good market at the equilibrium real interest rate reduces the demand for labor below full employment. Given the Phillips curve above, Wage flexibility *per se* does not help. As long as a response of current wages to low demand does not impinge on expected inflation, scaling down labor costs today and in the future cannot have any real effect in equilibrium.

Proposition 1 states that a small open economy *can* find itself in a full employment steady state even if the rest of the world is not. Intuitively, it can "export the problem", in that domestic full employment requires a weaker real exchange rate, so to increase the world demand for the country's output. This allows the country to export its excess saving, and build up net foreign assets.

To dig deeper into the mechanism, observe that, by the Phillips Curve (15), full employment is not attainable at a negative inflation rate. In the full employment steady state, domestic inflation must necessarily be higher than in the secular stagnation equilibrium. From purchasing power parity (6) and the fact that the real exchange rate must be constant in steady state, this also implies that the small open economy must experience trend nominal depreciation, at a rate determined by the ratio of the domestic inflation target and the negative inflationary drift abroad:

$$\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} = \bar{\Pi}/\Pi^* > 1. \tag{22}$$

It follows that a full employment steady state is feasible only under exchange rate flexibility. If domestic monetary policy pursues a fixed exchange rate target, the domestic policy makers must accept an inflation rate identical to the international one, which is negative and associated with stagnation.

However, a higher rate of inflation does not translate into a lower real rate. With integrated financial markets, the real interest rate in the domestic economy is pinned down by its ROW counterpart up to (expected) changes in the real exchange rate

$$(1 + r_t) = (1 + r_t^*)\frac{Q_{t+1}}{Q_t}, \tag{23}$$

where we have combined the domestic Fisher equation (7) and its foreign counterpart, the UIP condition (8) and purchasing power parity (6). Because in steady state, the real exchange rate must be constant, it follows that $r = r^*$. As a result, from the perspective of the small domestic economy, the domestic real rate is exogenous in steady state and therefore the same in both the employment and stagnation steady state.

This has two key implications. First, since the real rate is exogenous from the vantage point of the domestic economy, full employment is not achievable without a boost in demand for domestically produced goods, requiring real depreciation. Second, because the real rate is identical in the two steady states, but the rate of inflation is strictly higher in the full employment than in the stagnation steady state, the domestic nominal rate must necessarily lift off zero, from Fisher equation (7).

As we have seen above, from equations (2), (3) and equation (13), equilibrium in the asset market requires that domestic savings (by the middle-aged) equal domestic borrowing (by the

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young) plus the net foreign asset position.

$$B_t^m = -B_t^y + NFA_t. \tag{24}$$

The stagnation steady state can be seen as the result of excessive desired savings that cannot be accommodated at full employment, because, given monetary policy (17), the real interest rate remains stuck above its market clearing level, in turn generating a negative output gap. As stated by Proposition 1, the country achieves full employment by taking its excess savings abroad and acquiring assets on foreigners.

4   The possibility of beggar-thy-self depreciation

The real exchange rate depreciation that is required to reach full employment produces contrasting effects on demand and welfare. On the one hand, it makes domestically produced goods cheaper, redirecting demand towards them. This is what raises the level of domestic production to potential. On the other hand, for any given output, it reduces the international value of domestic production. Everything else equal, this makes domestic residents poorer. With incomplete markets, the income effects from depreciation are not mitigated by risk diversification via financial markets. They can actually become stronger than the substitution effects (see Corsetti et al. (2008b) and Corsetti et al. (2008a)).

Proposition 2. *Depending on the extent of real depreciation that is required to bring the economy to full employment, the full employment steady state characterized in Proposition 1 may be either welfare improving or welfare deteriorating. For a trade elasticity that is sufficiently low, below approximately $\sigma < 1/(2-\omega)$, the full employment steady state produces lower levels of domestic consumption despite higher levels of domestic production. The escape to full employment in this case is beggar thy self.*

Proof. See the Appendix A.2. $\square$

The equilibrium rate of real depreciation depends on the degree of substitutability between domestic and foreign production, as captured by trade elasticity σ. Intuitively, as domestically produced and imported goods become complementary, a large swing in relative prices is required in order to incentivize agents to switch expenditure from one to the other. Hence with a lower trade elasticity, the extent of real depreciation in the escape increases. At the same time, real depreciation, all else equal, reduces the purchasing power of domestic households internationally. As stated in Proposition 2, for a trade elasticity below $\sigma < 1/(2-\omega)$, this effect is strong enough for domestic consumption to actually *fall*—notwithstanding the rise in domestic production.

The main lesson is apparent. For a range of low trade elasticities, a country can still escape secular stagnation via depreciation. But strong income effects from the adverse movements in the terms of trade create a trade-off by which the full-employment steady state may not be welfare improving. Unless there are large utility gains from preventing involuntary unemployment, of the kind advocated by Schmitt-Grohé and Uribe (2016), a "currency war" can then be beggar thy self.

5 The escape path

We have established the existence of a full-employment steady state for the small domestic economy. In this section, we rely on numerical analysis to study how the domestic economy escapes stagnation by solving explicitly for the transition path to full employment. We design our exercises taking advantage of the fact that the equilibrium in the model is globally indeterminate, in that the dynamics can be affected by "sunspot shocks". Starting from the steady state of stagnation, we posit that a change in beliefs triggers transition to the full employment steady state.[9]

Below we consider the escape of a country that is not at the risk of beggar thy self. The transition to full employment may be summarized as follows. The country first experiences a large upfront nominal and real depreciation, as well as a temporary rise in both nominal and real interest rates relative to the initially depressed steady state. Thereafter, the economy steadily recovers and runs current account surpluses. In the long run, the country finds itself in the new steady state characterized by a permanently depreciated real exchange rate, and a positive stock of net foreign assets.

Recall that what drives the transition is a change in expectations by market participants that sets the economy on a higher inflation path, away from stagnation. In response, output rises gradually towards its potential value. There are two factors contributing to the output path. On the one hand, domestic inflation is increasing in both the level and the growth rate of domestic output as can be seen from the Phillips curve (15).[10] On the other hand, by assumption the monetary authorities credibly implement a monetary policy rule that prevents

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[9]For a discussion of global indeterminacy, see earlier models of inflation targeting under a zero lower bound constraint (for example Benhabib et al. 2001). Benhabib et al. (2002) discuss how global indeterminacy can be ruled out in a closed economy setting with a zero lower bound. Mertens and Ravn (2014) study "optimism" versus "pessimism" affecting dynamics under global indeterminacy in a closed-economy New Keynesian model. Cochrane (2011) critically reviews papers trying to resolve global indeterminacy.

[10]To see this more clearly rewrite the Phillips curve as

$$\Pi_{H,t} = \left[1/\gamma \, \left(\frac{Y_t}{Y_{t-1}} \right)^{(\alpha-1)/\alpha} - (1-\gamma)/\gamma \, \left(\frac{Y^f}{Y_{t-1}} \right)^{(\alpha-1)/\alpha} \right]^{-1}.$$
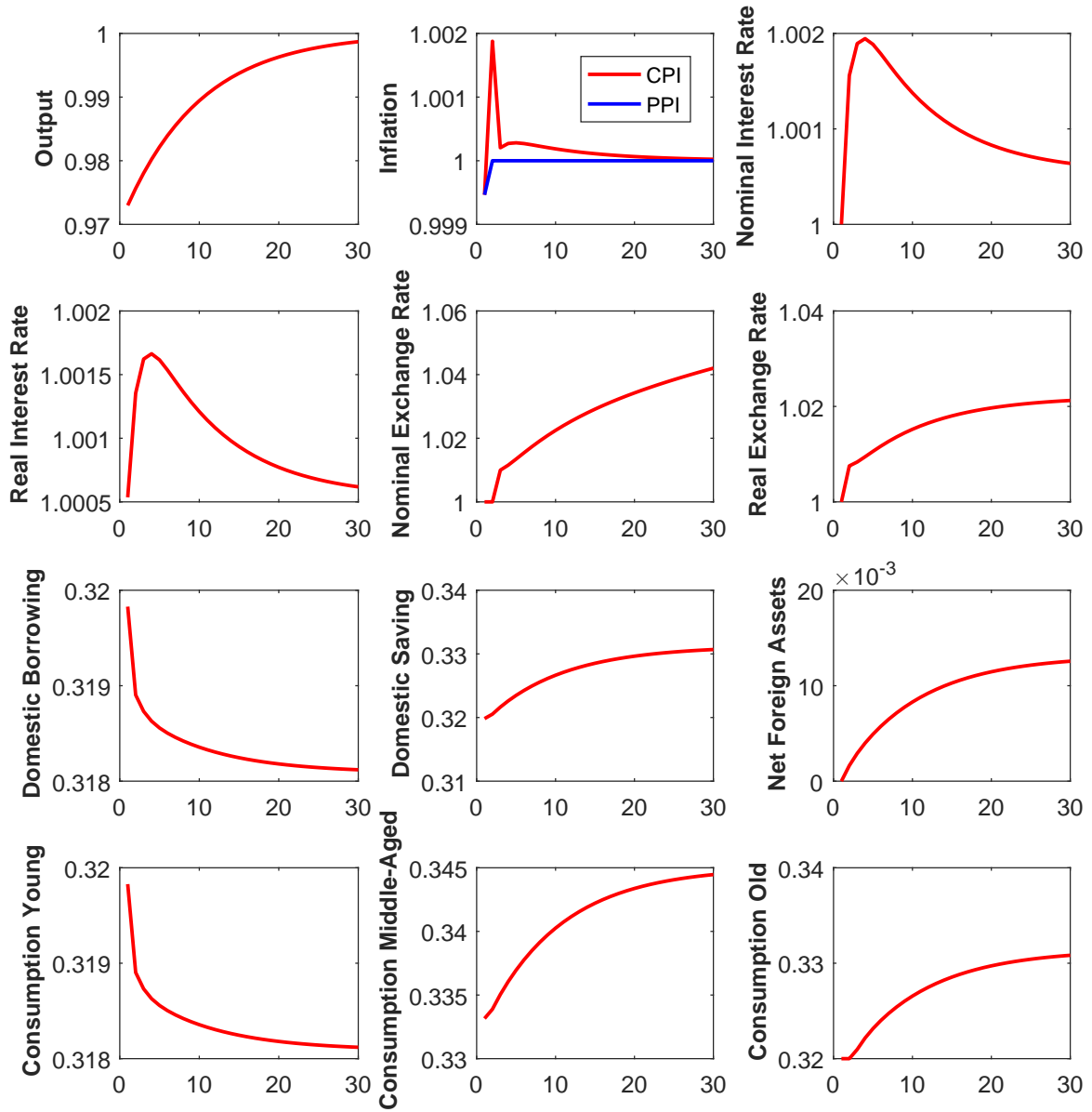
Figure 1: Transition to full employment. The case of a welfare improving escape. We are using the same parameter values adopted by Eggertsson et al. (2016). Hence we are using $\beta = 0.96, \alpha = 0.85, \gamma = 0.9, \rho = 1, \bar{L} = 1, D = 0.32, \bar{\Pi} = 1$. For the parameters that are not in their study, we are using an import share of $\omega = 0.2$, as well as a trade elasticity of $\sigma = 1$.

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domestic inflation to grow higher than the target (17). Thus, as the level of output increases, the growth rate that is consistent with target domestic inflation needs to fall and output asymptotes towards full employment.

To reach the full employment steady state, the real exchange rate must weaken on a permanent basis. Thus, the shift in expectations bringing the economy on the escape path results in a shift in the end-point of the real UIP condition (23), since agents expect a depreciated real exchange rate in the long run. To avoid too much of a jump in output, and hence a violation of the inflation target, however, the impact depreciation of the real exchange rate must be limited. Therefore, the real interest rate rises along the transition path to control the pace of depreciation such that output rises at a decreasing rate, consistent with the inflation target. Upon approaching the new steady state, the real interest rate eventually settles down on its pre-transition value, again by equation (23).

The nominal depreciation accommodates the real depreciation along the escape path, and, in addition, reflects the difference between the domestic inflation target and the deflationary drift in the ROW—as discussed above, escape from stagnation requires domestic inflation to outpace foreign inflation, implying trend nominal depreciation. The nominal interest rate jumps up from UIP condition (8), and comes down again gradually as the speed of nominal depreciation subsides. In the long run, the nominal interest rate is strictly positive, and equals the real rate that is the same as under stagnation, divided by the domestic inflation target, by implication of the Fisher equation (7).

It is interesting to observe that, as the economy recovers, consumption of the young actually *falls*, while the consumption of the middle-aged and old increases. The latter reflects that, because trade elasticities are high by assumption, the national income valued at international prices increases along the escape. In contrast, the young are unambiguously negatively affected by the escape, for two reasons. First, the real exchange rate depreciation affects the balance sheet of the young: the collateral against which they can borrow becomes less valuable in terms of their consumption. Second, the real interest rate rises, such that their borrowing becomes more expensive. Still, for each generation, the contraction in consumption when young is more than compensated by the gain in consumption when middle-aged and old: a 'jam-tomorrow' result by which there are net gains over their life-cycle, and overall the escape is welfare improving.[11,12]

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[11]Note that this result also depends on our modelling utility as deriving only from consumption. In contrast, if the higher labour supply associated with higher production at full employment carries utility losses, this result may be overturned. In contrast, if there are utility gains from avoiding involuntary unemployment, of the kind advocated in Schmitt-Grohé and Uribe (2016), this result may be further strengthened.

[12]In one key dimension the escape path discussed is reminiscent of Svensson's "Foolproof Method" to escape a liquidity trap in an open economy: what jumps-start the economy is an increase in inflation expectations

The escape path is different when the economy is affected by beggar thy self. In the Appendix A.3 we show the equivalent of Figure 1 in such an economy. The negative welfare implications of the escape are illustrated by the fact that the consumption of all generations drops along the transition. Interestingly, in this case, the savings by the middle-aged contract along with the borrowing by the young. Yet, capital outflows remain positive because the contraction of domestic borrowing outpaces the contraction of domestic saving. In the Appendix A.6, we also show the escape path for an economy in which trade elasticities are initially low, but rising along the transition to the new steady state. The motivation for this is the empirical evidence that trade elasticities may vary at different time horizons: see for example Ruhl (2008) and Crucini and Davis (2016). A notable novel result is that, with trade elasticities changing over time, the exchange rate overshoots in the initial phase of the escape. As a result, the lift-off of the nominal interest rate from zero is not immediate, but the nominal rate remains stuck at its zero-bound for a number of periods.

6 Capital flows and asset supply

In this section we analyze two issues related to capital account liberalization and financial regulation policies. First, we ask whether a country may be better off by closing down its border to trade in assets. This is tantamount to ask whether trade openness may help a country escape secular stagnation without changing its external position. Second, we study the effects of loosening domestic credit conditions via policies that foster access to financial resources by constrained agents.

6.1 Restricting capital mobility: Financial autarky

Our first question is whether the country may be better off by giving up financial integration. A potential benefit is that absent trade in cross-border assets, the UIP condition (8) does not need to hold in equilibrium. As a result, also the UIP condition in real terms (23) is not an equilibrium condition, such that domestic policy makers re-gain control over the domestic real rate of interest. Hence the country may expect to raise the demand for its output up to full employment via a combination of lower real rates (below the international level) and a depreciated real exchange rate—without any need to run current account surpluses. Our

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associated with a weakening of the nominal and real exchange rate (Svensson 2001 and Svensson 2003). However, Svensson focuses on the escape from a temporary liquidity trap, assuming a unique steady state. In this context, because of the presence of nominal rigidities, a boost in demand and temporary depreciation requires a *fall* in real interest rates. In Figure 1, instead, depreciation and inflation are associated with a temporary *rise* in real rates—a common result in contributions modelling the escape from a liquidity trap as a transition between two, stagnation and full employment, steady states—see, e.g., Schmitt-Grohe and Uribe (2012) or Cochrane (2011).

model yields an important benchmark result.

Proposition 3. *For our small open economy, consider the case of financial autarky such that the domestic economy opens its goods markets but the capital market remains closed and hence $NFA_t = 0$ at all times, implying that the uncovered interest parity (equation (8)) does not need to hold in equilibrium. The secular stagnation equilibrium is now unique: the multiplicity of equilibria characterized in Proposition 1 disappears.*

Proof. Consider equation (13) in steady state, where it is imposed that $NFA = 0$. Multiplying both sides with P and dividing by P_H, we obtain

$$\frac{D}{1+r} = \frac{1}{1 + [\beta(1+r)^{1-\rho}]^{-\frac{1}{\rho}}}(Y - D).$$

Because of symmetry with the rest of the world (Assumption 1), for $Y = Y^f$ this equation is solved by $r = r_{nat}$—see section 2.7. Yet because r_{nat} is sufficiently negative by assumption, $r = r_{nat}$ is incompatible with the zero lower bound constraint, $i \geq 0$. $\qquad\square$

In financial autarky, escape from secular stagnation via depreciation is a balancing act between raising foreign demand and containing internal balance sheet effects. On the one hand, higher foreign demand moves the economy to full employment, which raises domestic savings. On the other hand, balance sheet effects on the young reduce the domestic borrowing. We have seen above that, in an economy open to asset trade, the consequence are capital outflows. In contrast, in a financially closed economy, the consequence is an equilibrium drop in the domestic real interest rate. Yet, as demonstrated in the proof of Proposition 3, this equilibrium drop would have to be so large as for the implied nominal interest rate to violate the zero lower bound constraint. Hence in our model specification, this balancing act from real depreciation resolves against full employment.

This line of arguments suggests that the equilibrium could be sensitive to the response of the households' balance sheet to real depreciation. To confirm this, in Appendix A.4 we specify the credit constraint on the young in terms of consumption rather than output units. In this specification of the model, the borrowing by the young hence the savings-absorption capacity of the economy does not fall with a weakening currency. As a result, the real rate needs to fall by less (not all the way to the natural rate) to bring asset demand back in line with asset supply, such that the implied nominal rate may remain positive. Moreover, in this case the escape from stagnation becomes more likely when the income effects from depreciation are strong, since, as the economy recovers from stagnation, desired savings by the middle-aged rise by little or may even fall (recall the discussion in Section 5).

From the proposition above, it is also clear that closing the economy financially would be innocent if the small open economy were in the parameter space outside the secular stagnation (if we relax the symmetry under Assumption 1). Specifically, if the domestic natural real rate r_{nat} were not negative, closing down financially would not be a drag. With enough saving-absorption capacity at full employment under financial autarky, monetary policy could stabilize the economy at positive nominal rates.

6.2 Relaxing the domestic financial constraints

In a closed economy, one way to raise the natural real interest rate and thereby to escape secular stagnation consists of loosening domestic credit conditions, see the discussion by Eggertsson and Mehrotra (2014). Indeed, policies that boost the amount of lending to the young (a larger D) not only increase their consumption demand, but also reduce the desired savings by the middle-aged.[13] As a result, the output gap narrows in the stagnation steady state, and the rate of deflation falls.

It is easy to see that relaxing the borrowing constraint on the young has a similar desirable effect in a small open economy that is under financial autarky. The logic is the same as in Eggertsson and Mehrotra (2014): by relaxing the domestic financial friction, the natural rate becomes progressively less negative, such that the economy moves away from secular stagnation (see also the previous subsection). This suggests that a policy of capital controls associated with domestic financial deepening may help a country close the output gap and overcome secular stagnation.

In sharp contrast, under financial integration, domestic real rates are determined abroad via equation (23), and are therefore insensitive to domestic savings imbalances. Hence, a policy of financial deepening cannot but be neutral in terms of domestic real rates in steady state. Then, from the Fisher equation (7), its ROW counterpart, and the fact that both countries are at the zero lower bound, the rates of deflation in the two countries must be synchronized in steady state, too. In turn, from the Phillips curve (15), the steady state output gaps in the two countries must also be perfectly aligned.

It does not follow, however, that financial deepening is neutral in terms of the equilibrium allocation. Precisely, a rise in D increases domestic borrowing B_t^y via equation (2), reduces domestic saving B_t^m via equation (3), and hence reduces the net foreign asset position via equation (24). Intuitively, as the young borrow more while the middle-aged save less, the economy experiences capital inflows: domestic households end up holding less foreign assets. As a consequence, income generated from foreign assets is lower in the new steady state, such

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[13]The latter follows from the fact that, if the household accumulates greater debts while young, it has fewer assets to save from when middle-aged.

that the real exchange rate depreciates and domestic consumption falls (in the Appendix A.5 we show these results analytically).

These effects are best understood in light of the "transfer problem", after Keynes (1929). The main issue concerns the effects on relative prices of transferring purchasing power from one country to another: in our model, a lower net foreign asset position can be interpreted as a domestic transfer to ROW. It is well known that, with home bias in consumption, the country that transfers resources experiences a fall in demand for its own output (as foreigners will demand proportionally more of theirs). Equilibrium then requires a domestic real depreciation. Moreover in the present context, because output and hence domestic incomes are unchanged with the transfer (as argued earlier on), only the income effect from the depreciation remains, such that the transfer unambiguously reduces domestic consumption. Therefore paradoxically, even if neutral with respect to aggregate output, an increase in the supply of domestic assets ends up being *beggar thy self*.

But while counterproductive from a domestic vantage point, raising the supply of assets in individual countries is always desirable from a global perspective (see CFG and EMSS). The analysis in this section reinforces the case for coordinated policy initiatives across borders. Taken in isolation, each individual country has an incentive to abstain from asset supply policies. If all countries relax the constraints symmetrically, there would be no effect on the exchange rate and net foreign assets and hence there would be a general improvement in macroeconomic conditions.

7 Reforming the monetary policy framework

A key result of the secular stagnation literature is that, with policy rates stuck at their lower bound, real interest rates endogenously rise above the market clearing level in steady state, depressing demand and generating negative output gaps forever. From a different perspective, at the equilibrium real rate, savings cannot be absorbed at full employment, given that there are insufficient savings vehicles in the economy.

In a closed economy context, there is therefore an argument for either increasing the target inflation, or for lowering the effective lower bound (ELB) constraint, i.e. set negative policy rates, in an attempt to enhance the ability of monetary policy to stimulate demand. In this section, we discuss the effectiveness of either measure in a small open economy that is financially integrated in world capital markets in turn.

7.1 A higher inflation target

In a closed economy, raising the inflation target can be helpful to the extent that the target is set above the negative of the natural real rate. In this case, the full employment steady state necessarily exists—and is characterized by a strictly positive nominal interest rate. However, as discussed in Eggertsson and Mehrotra (2014), a revision of the target by itself does not rule out the stagnation steady state. In this sense, the measure is less effective as a tool for forward guidance than in economies where the duration of the zero lower episode is finite (Eggertsson and Woodford 2003).

In our small open economy the policy's benefits are even subtler. A higher target by itself does not affect the existence of the two steady states, given that the full employment steady state exists even for an inflation target that would imply uniqueness of equilibrium if the economy were (financially or entirely) closed. Moreover, the mechanism by which the full employment steady state exists does not rely on a high enough inflation target enabling the domestic real rate to match the (negative) natural real rate. Instead, the domestic real rate *exceeds* the natural real rate even in the full employment steady state, and this is completely independent of the domestic inflation target (as long as it is not too much below zero), given that domestic real rates are determined internationally.[14]

What *can be* altered via a change in the inflation target is the transition to full employment discussed in Section 5. Recall Figure 1 where, along the escape path, per effect of shifting expectations, domestic policy makers hit their inflation target instantly, as the zero lower bound ceases to bind in the period of the lift-off. Thus with a higher inflation target, the recovery is accompanied by higher levels of inflation, with two key implications. On the supply side, from the Phillips Curve (15), output recovers more quickly, by relaxing the downward constraint on nominal wages at a faster pace.[15] On the demand side, the transition is fostered by faster depreciation towards the new steady state of the exchange rate.

7.2 A lower effective lower bound (ELB)

In a closed economy, lowering the effective lower bound (ELB) on policy rates helps alleviate stagnation. This is because, as the nominal rate falls, the real rate also falls thereby moving

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[14]That is, as long as the domestic inflation target is above the lowest level of inflation associated with a permanent output gap, it is neutral as regards the allocation. The domestic monetary authorities can pursue any such target, and simply let the nominal exchange rate depreciate at the rate implied by condition (22). The lowest possible level for the inflation target is determined by the downward wage rigidity. For example, if wages can fall at most 1 percent per quarter, the target must be higher than minus 4 percent annually.

[15]By repeating the experiment from Figure 1, but under an inflation target which has been raised slightly, we note that output recovers more quickly, and at some point jumps to potential straight away, in the period where the wage constraint ceases to bind altogether. This occurs when $\Pi_{H,t} > (Y^f/Y_{t-1})^{(1-\alpha)/\alpha}$, recall the equations (15) and (16).

closer to the (negative) natural rate rate. As the gap between the real rate and its natural counterpart is reduced, the (negative) output gap narrows.

In our small open economy, the same policy has no such effect, but is instead counterproductive: it makes inflation more negative, and thus exacerbates the underemployment problem. Formally, when the ELB is lowered to negative territory, (17) and (18) change to

$$\Pi_{H,t} = \bar{\Pi} \ \text{ subject to } \ i_t \geq -\bar{i}_{\text{ZLB}},$$

along with

$$i_t = -\bar{i}_{\text{ZLB}} \ \text{ if } \ \Pi_{H,t} < \bar{\Pi},$$

where $\bar{i}_{\text{ZLB}} > 0$ is the degree of effective relaxation of the zero bound constraint. From the Fisher equation (7) and its ROW counterpart, it follows that domestic inflation falls below inflation in ROW as $i = 0$ falls to $i = -\bar{i}_{\text{ZLB}}$, again because domestic (long run) real rates are determined internationally and hence not affected by domestic policy. That is, as $\bar{i}_{\text{ZLB}} > 0$ and the economy is in the stagnation steady state, the economy must experience a higher rate of deflation than ROW, which, from Phillips curve (15), implies an even deeper recession—in fact, deeper than the recession in the rest of the world.

Hence again, and in line with the arguments made in the previous section, a policy that has an overall favourable effect when the economy is (financially or entirely) closed, turns out to be *beggar thy self* when the economy is financially open.

In concluding this subsection we observe that, under financial integration, a lower ELB is irrelevant as long as the policy rate is positive. This is the case in Figure 1, where the zero lower bound is binding neither along the escape transitional dynamics, nor in the full employment steady state. The measure may be useful however in economies where, along the escape, the zero longer bound remains binding for a few periods. An example is given in Figure 3 in Appendix A.6. In such a case, once the economy is on the escape path, a lower ELB allows a faster recovery in the conventional way, as it shortens the length of time in which monetary policy is constrained.

8 Empirical Evidence

While the crisis still weighs on global economic activity, a number of small open economies have been able to maintain high level of domestic employment and positive growth rates. Classical open macro theory suggests that a single country can insulate its macro economy from adverse external conditions by letting its exchange rate absorb the contraction in world demand, and improve its external surplus.

Our model predicts that, at times when the world as a whole is underemployed, countries with positive net foreign asset positions and weaker real exchange rates have lower unemployment. The model predicts the existence of multiple equilibria and in this sense does not embed a causal link from one variable to another. Nonetheless, it still predicts the existence of conditional correlations.

We show that the pattern of correlations exists in the data. Specifically, we consider regressions of the form

$$y_{it} = \alpha_i + \beta_0 nfa_{it} \left(1 + \beta_1 y_t\right) + \gamma_0 q_{it} \left(1 + \gamma_1 y_t\right) + \epsilon_{it} \tag{25}$$

where y_{it} is a measure of domestic activity relative to potential (the output gap or the negative of unemployment or the unemployment gap, measured at yearly frequency in the IMF WEO database) and y_t is its global average, nfa_{it} is the ratio of net foreign assets to GDP (from the Lane and Milesi-Ferretti (2011) database) and q_{it} is the terms of trade, taken from the Penn World Tables version 9.0, with a depreciation defined as an increase. Our model predicts that the interactions between global output and both the net foreign assets ratio and the terms of trade will be negative—a more positive net foreign asset position will raise employment, as will a depreciation in the terms of trade (defined as an increase in q), by more when the global economy is depressed.

Table 1 displays the results for the regressions. The magnitude and significance of the coefficients are somewhat sensitive to specification, but are generally in line with the predictions of the model. Columns 1 and 3 show the partial correlations for the output gap and the (negative of the) unemployment gap as our measure of resource utilization. In both cases, an improvement in the terms of trade (equivalent to a real appreciation in our model) is associated with a lower level of resource utilization. Moreover, the interaction terms are significant and negative: in a global downturn, unemployment is systematically lower in countries with positive net foreign asset positions and weaker real exchange rates.

Table 1: Partial correlation between net foreign assets, terms of trade and domestic output gap

VARIABLES	(1) y-gap	(2) y-gap	(3) u-gap_neg	(4) u-gap_neg
NFA/Y	0.040	0.107	0.292***	-0.020
	[0.15]	[0.15]	[0.10]	[0.11]
Terms of Trade	8.731***	9.852***	2.045*	0.051
	[2.26]	[2.25]	[1.21]	[1.22]
NFA * mean(y-gap)		-0.136**		
		[0.06]		
Terms of Trade * mean(y-gap)		-4.374***		
		[0.82]		
NFA * mean(u-gap_neg)				-0.490***
				[0.11]
Terms of Trade * mean(u-gap_neg)				-6.558***
				[1.10]
Observations	1,965	1,965	1,029	1,029
R-squared	0.008	0.029	0.014	0.079
Number of countryno	85	85	37	37

The table reports the results from running the following regressions

$$y_{it} = \alpha_i + \beta_0 nfay_{it}\left(1 + \beta_1 y_t\right) + \gamma_0 tot_{it}\left(1 + \gamma_1 y_t\right) + \epsilon_{it} \tag{26}$$

where y_{it} is a measure of domestic activity relative to potential (the output gap or the negative of unemployment or the unemployment gap); y_t is its global average, $nfay_{it}$ is the ratio of net foreign assets to GDP and tot_{it} is the terms of trade (with a depreciation defined as an increase). The sample period is 1980-2011, the frequency is yearly. Unemployment or the unemployment gap are from the IMF WEO database; the net foreign asset positions used to calculate $nfay_{it}$, the ratio of net foreign assets to GDP, are from the database by Lane and Milesi-Ferretti (2007)); tot_{it}, the terms of trade, is taken from the Penn World Tables version 9.0.

9 Conclusion

This paper shows that small open economies in a world of secular stagnation can attain full employment by depreciating their currencies and acquiring net foreign assets. Yet, weakening terms of trade can reduce domestic welfare even though output rises to full employment. The adjustment path can involve a hike in real and nominal interest rates. In the long run, real interest rates remain unchanged at the level determined in international asset markets, while nominal interest rates rise above zero, commensurate with the higher inflation and nominal depreciation at full employment.

Our relatively simple model illustrates that cross-border trade in goods and assets offers important adjustment margins and opportunities to avoid stagnation. Yet, with full financial market integration, policy prescriptions relating to closed economies in temporary downturns—i.e. to temporary liquidity traps in standard New Keynesian models—do not straightforwardly translate to open economies in potentially permanently depressed environments. To the extent that arbitrage in capital markets constrains real rates, lowering the nominal interest rates below zero can be harmful, rather than helpful, as is the case in closed economy models or models of temporary downturns. Similarly, relaxing the domestic frictions that constrain domestic borrowing is neutral in terms of output, yet beggar thy self in terms of consumption when asset markets are internationally integrated.

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A   Appendices

A.1   Model equations

The home economy model can be summarized by the following equations: Stock equation for the *net foreign asset position*

$$NFA_t = -\frac{D_t}{1+r_t}\frac{1}{\phi_{t+1}} + \frac{1}{1+[\beta(1+r_t)^{1-\rho}]^{-\frac{1}{\rho}}}\frac{1}{\phi_t}(Y_t - D_{t-1})$$

as well as the flow equation

$$NFA_t = (1+r_{t-1})NFA_{t-1} + \frac{Y_t}{\phi_t} - C_t.$$

Aggregate demand equation:

$$Y_t = \phi_t^\sigma \left((1-\omega)C_t + \omega Q_t^\sigma Y^*\right)$$

Price indexes, Fisher and UIP equations:

$$
\begin{aligned}
Q_t &= \frac{S_t}{\phi_t}\\
\frac{S_t}{S_{t-1}} &= \frac{\mathcal{E}_t/\mathcal{E}_{t-1}\Pi^*}{\Pi_{H,t}}\\
\phi_t &= [(1-\omega)+\omega(S_t)^{1-\sigma}]^{\frac{1}{1-\sigma}}\\
(1+r_t) &= (1+r^*)\frac{Q_{t+1}}{Q_t}\\
(1+i_t) &= (1+i^*)\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}
\end{aligned}
$$

The *aggregate supply* and *policy rule* given by:

$$
\begin{aligned}
Y_t &= \left[\gamma\frac{Y_{t-1}^{\frac{\alpha-1}{\alpha}}}{\Pi_{H,t}} + (1-\gamma)(Y^f)^{\frac{\alpha-1}{\alpha}}\right]^{\frac{\alpha}{\alpha-1}}\\
1+i_t &= 1
\end{aligned}
$$

around the unemployment steady state (as long as $\Pi_{H,t} < (Y^f/Y_{t-1})^{\frac{1-\alpha}{\alpha}}$), and by

$$
\begin{aligned}
Y_t &= Y^f\\
\Pi &= \bar{\Pi}
\end{aligned}
$$

around the full employment steady state. For simplicity and without loss of generality, in the following we assume that $\bar{\Pi} = 1$ and $Y^f = 1$.

A.2 Existence of steady states

The steady state in the domestic economy is characterized by the following set of equations:

$$NFA = -\frac{D}{1+r}\frac{1}{\phi} + \frac{1}{1+[\beta(1+r)^{1-\rho}]^{-\frac{1}{\rho}}}\frac{1}{\phi}(Y-D) \tag{A.1}$$

$$NFA = (1+r)NFA + \frac{Y}{\phi} - C \tag{A.2}$$

$$Y = \phi^\sigma\left((1-\omega)C + \omega Q^\sigma Y^*\right) \tag{A.3}$$

$$Q = \frac{S}{\phi} \tag{A.4}$$

$$\Delta S = \frac{\Delta\varepsilon\Pi^*}{\Pi_H} \tag{A.5}$$

$$\phi = [(1-\omega)+\omega(S)^{1-\sigma}]^{\frac{1}{1-\sigma}} \tag{A.6}$$

$$(1+r) = (1+r^*)\Delta Q \tag{A.7}$$

$$(1+i) = \Delta\varepsilon \tag{A.8}$$

$$Y = \{ \begin{array}{l} Y^f\left[\frac{(1-\gamma/\Pi_H)}{(1-\gamma)}\right]^{\frac{\alpha}{\alpha-1}} \text{ otherwise} \\ Y^f \text{ if } \Pi_H \geqslant \bar{\Pi} \end{array} \tag{A.9}$$

$$\Pi_H = \bar{\Pi} \text{ or } 1+i = 1 \tag{A.10}$$

In steady state the real interest rate in the domestic economy will be the same as the real rate in ROW. So, from the steady state value of real interest rate in the ROW (21), and from equation (A.7), $(1+r) = (1+r^*) = 1/\Pi^*$, where have used that $\Delta Q = 1$ in steady state. Then, (A.4) and (A.6) imply that the relative prices remain constant, $\Delta S = \Delta\phi = 1$.

A.2.1 Existence of stagnation steady state

In this case the zero lower bound is binding such that $1+i = 1$. Then, $\Pi_H = \Pi^*$ and $Y = Y^f\left[\frac{(1-\gamma/\Pi^*)}{(1-\gamma)}\right] = Y^*$ from (A.5), (A.8) and (A.9) respectively (in steady state $\Delta S = 1$). Now guess that in this steady state, $Q = S = \phi = 1$ and $NFA = 0$. We see that (A.1) is satisfied in this case, because this equation is then the same as its ROW counterpart in Section 2.7—recall that we had assumed symmetry across the two countries. Equation (A.2) then implies $C = Y = Y^*$, which is also compatible with equation (A.3) once $\phi = Q = 1$. Finally, the price indexes Q, S, ϕ are all compatible with equations (A.4) and (A.6).

A.2.2 Existence of full employment steady state

The proof of the full employment steady state is more intricate. First rearrange the above system of equations. Using (A.1) and (A.2) in (A.3) we derive:

$$Y = \phi^\sigma[(1-\omega)(r^*NFA + Y\phi^{-1}) + \omega Q^\sigma Y^*]$$

$$Y(1 - \phi^{\sigma-1}(1-\omega)) = \phi^\sigma(1-\omega)r^*NFA + \omega\phi^\sigma Q^\sigma Y^*$$

$$Y(1 - \phi^{\sigma-1}(1-\omega)) = \phi^{\sigma-1}(1-\omega)r^*(-\frac{D}{1+r^*} + M(Y-D)) + \omega\phi^\sigma Q^\sigma Y^*$$

$$Y(1 - (1-\omega Q^{1-\sigma})(1+r^*M)) = -(1-\omega Q^{1-\sigma})r^*D(\frac{1}{1+r^*} + M) + \omega(\frac{1-\omega}{1-\omega Q^{1-\sigma}})^{\frac{\sigma}{1-\sigma}}Q^\sigma Y^*$$

$$(\text{A-11})$$

where $M \equiv \dfrac{1}{1+[\beta(1+r^*)^{1-\rho}]^{-\frac{1}{\rho}}}$ and where, in the last step, we have combined (A.4) and (A.6) to obtain $\phi = (\frac{1-\omega}{1-\omega Q^{1-\sigma}})^{\frac{1}{1-\sigma}}$. Note that equation (A-11) can be seen as determining Q for any given Y. The existence of the full employment steady state therefore depends on the existence of a Q which solves this equation for given $Y = Y^f = 1$.

Case 1: $\sigma \neq 1$ Rewrite equation (A-11) as:

$$1 - (1-\omega Q^{1-\sigma})(1+r^*M) + (1-\omega Q^{1-\sigma})r^*D(\frac{1}{1+r^*} + M) - \omega(\frac{1-\omega}{1-\omega Q^{1-\sigma}})^{\frac{\sigma}{1-\sigma}}Q^\sigma Y^* = 0$$

Denote this equation as $f(Q) = 0$. The first key observation is that $f(1) > 0$. This is because, from the proof of the existence of the stagnation steady state above, $f(1) = 0$ under $Y = Y^* < Y^f$. Because here we assume that $Y = Y^f$, the first term in this expression becomes more positive such that the whole expression becomes greater than zero. Second, consider $\sigma < 1$ and note that f tends to minus infinity as Q tends to $\omega^{\frac{1}{\sigma-1}} > 1$. Therefore, in this case, because f is continuous on $(1, \omega^{\frac{1}{\sigma-1}})$, there must exist an intermediate $1 < Q < \omega^{\frac{1}{1-\sigma}}$ such that $f(Q) = 0$. Instead, for $\sigma > 1$, note that f tends to minus infinity as Q tends to plus infinity. Therefore, in this case, because f is continuous on $(1, \infty)$, there must exist an intermediate $1 < Q < \infty$ such that $f(Q) = 0$.

Case 2: $\sigma = 1$ In this case (A-11) can be written as:

$$(1 - (1-\omega)(1+r^*M)) + (1-\omega)r^*D(\frac{1}{1+r^*} + M) - \omega Q^{\frac{1}{\omega}}Y^* = 0$$

where we have used that, once $\sigma = 1$, $\phi = Q^{\frac{1-\omega}{\omega}}$ from equations (A.4) and (A.6). Again, from previous arguments, this function $f(Q)$ is positive for $Q = 1$, and it tends to minus infinity as Q tends to plus infinity. Therefore, because f is continuous on $(1, \infty)$, there must exist an intermediate $1 < Q < \infty$ such that $f(Q) = 0$.

We next derive the NFA position that supports the full employment steady state. Using equation (A.1) we get:

$$NFA = \frac{1}{\phi}\left(-D\Pi^* + \frac{1}{1 + [\beta\Pi^{*1-\rho}]^{-\frac{1}{\rho}}}[Y - D]\right).$$

We have shown that $NFA = 0$ under $Y = Y^*$ and $\phi = 1$. As a result, $NFA > 0$ as $Y = Y^f > Y^*$, even though the size of the (positive) NFA position is dampened by $Q > 1$ and therefore $\phi > 1$ in the full employment steady state.

A.3 Beggar thy self

A.3.1 Derivation of threshold

We show that, once σ falls below some (approximate) threshold, the full employment steady state deteriorates welfare relative to the stagnation steady state. Specifically, we show that $C^{fe} < C^{stag}$ for σ low enough, given that in our model welfare and aggregate consumption are directly related (compare equation (1)).

Start with combining the equations for the asset flow (A.2), aggregate demand (A.3), and price indexes (A.4) and (A.6) from Appendix A.1 to obtain

$$Y_t(1 - (1 - \omega Q_t^{1-\sigma})) = (\frac{1 - \omega}{1 - \omega Q_t^{1-\sigma}})^{\frac{\sigma}{1-\sigma}}[(1 - \omega)((1 + r_{t-1})NFA_{t-1} - NFA_t) + \omega Q_t^\sigma Y^*],$$

which determines Q_t for given Y_t and NFA_t. Log-linearizing this equation around the stagnation steady state (characterized by $Q = 1$ and $NFA = 0$, see above) gives

$$q_t = \left(\frac{2 - \omega}{1 - \omega}\sigma - 1\right)^{-1} y_t \equiv \kappa y_t. \tag{A.12}$$

Up to first order, equation (A.12) determines the required real depreciation necessary as the economy moves to the full employment steady state (i.e. the required depreciation is κ times the increase in output). Note in particular that κ falls in σ, such that the required real depreciation is smaller as the trade elasticity increases.

Second, log-linearizing the asset flow from Appendix Section A.1 around the stagnation steady state yields

$$c_t = y_t - \frac{\omega}{1 - \omega}q_t. \tag{A.13}$$

Now combine equations (A.12) and (A.13) to obtain

$$c_t = \left(1 - \frac{\omega}{1 - \omega}\kappa\right) y_t, \tag{A.14}$$

such that, up to first order, moving to the full employment steady state is welfare improving if $\omega\kappa/(1-\omega) < 1$. Recalling the definition of κ and rearranging yields

$$\sigma > \frac{1}{2-\omega}, \tag{A.15}$$

which is the condition stated in the main text.

A.3.2 Escape path under beggar thy self

The transition for the case of low trade elasticity is depicted in Figure 2, where we use the same parameter values as in Section 5, except for the trade elasticity which now is $\sigma = 0.46$. As explained in the main text, with a low trade elasticity, the income effects from depreciation are strong: note that the rate of depreciation is higher than in Figure 1. As a result, domestic consumption falls on impact, driven by a contraction in income valued at international prices (i.e. $P_{H,t}/P_t$ falls faster than Y_t rises), and keeps falling towards a new, lower, steady state level. The domestic savings fall along with the consumption of the middle-aged, again due to the strong income effects from depreciation. Still, because the domestic borrowing contracts faster than the saving—due to the borrowing constraint of the young becoming tighter as a result of the depreciation—the net foreign asset position increases in the escape. Overall, the large adverse terms of trade movements have a negative effect on consumption for all generations, such that the escape is beggar thy self.

A.4 Alternative model specification

Following up on Section 6.1, here we consider an alternative specification for the model where the borrowing constraint is expressed in terms of domestic consumption rather than output units. That is, we replace equation (2) by $C_t^y = -B_t^y = D_t/(1+r_t)$. As a result, the flow net foreign asset condition changes to

$$NFA_t = -\frac{D_t}{1+r_t} + \frac{1}{1 + [\beta(1+r_t)^{1-\rho}]^{-\frac{1}{\rho}}}\left[\frac{1}{\phi_t}Y_t - D_{t-1}\right] \tag{A.16}$$

while all other equations remain as summarized in Appendix Section A.1—that is, the rest of the model remains unaffected by this adjustment.

As can be seen from equation (A.16), the difference with respect to the baseline model is that the borrowing constraint by the young now does not tighten per effect of the real depreciation. This has two key implications.

First, in the region where σ is sufficiently low for the escape to be beggar thy self, the escape may actually be accompanied by capital *inflows*, rather than capital outflows. Intuitively, this is because the savings-absorption capacity of the economy is unchanged with the depreciation,
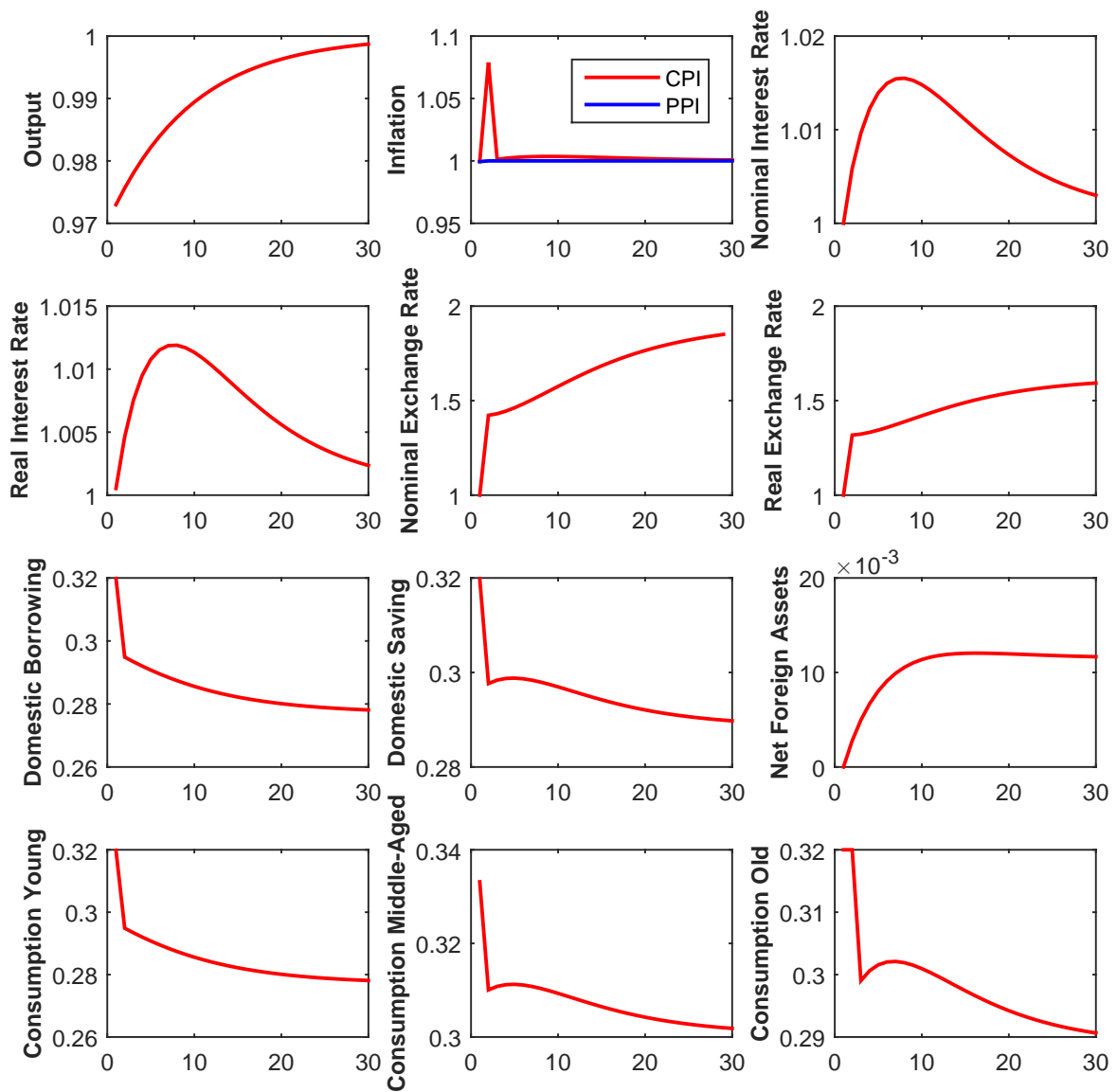
Figure 2: Transition to full employment. Case of beggar-thy-self escape. We are using the same parameter values as in Figure 1, except for the trade elasticity which we set to $\sigma = 0.46$.

while the savings are compressed by the middle-aged being subject to the strong income effects from the depreciation. Second, as a result, escape to full employment under financial autarky may actually be possible under this alternative specification (as mentioned in Section 6.1). This is because, again from equation (A.16), the real depreciation which raises output to full employment simultaneously reduces the drop in the domestic real rate that is required to solve equation (A.16) under $NFA_t = 0$. In intuitive terms, because the real depreciation directly reduces domestic excess savings, escape without accumulating external assets may be possible even with very small changes in domestic real interest rates.

A.5   Asset supply policies

Following up on Section 6.2, here we show formally that, by relaxing the domestic borrowing by the young while the economy finds itself in stagnation (i.e. raising $D > D^*$), this results in a steady state real depreciation, a fall in net foreign assets, and a drop in aggregate consumption. To do so, first recall that changing D leaves unaffected the amount of domestic output $Y = Y^* < Y^f$ and the real interest rate $r = r^*$.

The following three equations from the model's steady state summarized in Appendix Section A.2 are required for this question

$$NFA = -\frac{D}{1+r^*}\frac{1}{\phi} + \frac{1}{1 + [\beta(1+r^*)^{1-\rho}]^{-\frac{1}{\rho}}}\frac{1}{\phi}(Y^* - D)$$

$$NFA = (1+r^*)NFA + \frac{Y^*}{\phi} - C$$

$$Y^* = \phi^\sigma\left((1-\omega)C + \omega Q^\sigma Y^*\right)$$

as well as $\phi = (\frac{1-\omega}{1-\omega Q^{1-\sigma}})^{1/(1-\sigma)}$. This is a three-by-three system in the variables (C, NFA, ϕ) for given exogenous D.

We conduct the following comparative statics exercise. We change D to a higher level, and study whether the implied (C, NFA, ϕ) from the previous equations increase or decline. To do so, we consider a linearization of the previous conditions around $Q = \phi = 1$, $NFA = 0$ and $C = Y^*$, which are the conditions in the initial (symmetric with ROW) stagnation steady state. Using small-case letters with a tilde to denote log-deviations for ϕ, Q, C and absolute deviations for NFA and D, we obtain

$$\tilde{nfa} = -1/(1+r^*) \, Y^*/(Y^* - D) \, \tilde{d}$$

$$\tilde{nfa} = (1+r^*)\tilde{nfa} - Y^*(\tilde{\phi} + \tilde{c})$$

$$0 = (1-\omega)\tilde{c} + (2-\omega)\sigma\tilde{\phi}$$

where in the last equation we have used that $\tilde{q} = (1-\omega)/\omega \, \tilde{\phi}$. The first equation shows that $\tilde{nfa} < 0$ as $\tilde{d} > 0$. That is, relaxing the domestic borrowing constraint unambiguously

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induces capital inflows. In turn, the second and third equation determine how those capital inflows impact on the real exchange rate and consumption.

Solving for the change in consumption $\tilde{c}$ by using the third equation yields

$$\tilde{c} = -\sigma \frac{2 - \omega}{1 - \omega} \tilde{\phi}, \tag{A.17}$$

such that consumption drops as the real exchange rate depreciates. Solving for the net foreign asset position from the second equation then gives

$$r^* \tilde{nfa} = -Y^* (\sigma \frac{2 - \omega}{1 - \omega} - 1) \ \tilde{\phi}, \tag{A.18}$$

such that, for $\sigma > (1 - \omega)/(2 - \omega)$, the net foreign asset position falls as the real exchange rate depreciates.[16]

Because $\tilde{nfa} < 0$ falls as $\tilde{d} > 0$ rises, we have established that the real exchange rate depreciates ($\tilde{\phi} > 0$ and hence $\tilde{q} > 0$ rises) from equation (A.18), and that consumption drops ($\tilde{c} < 0$ falls) from equation (A.17).

A.6 Discussion of trade elasticities

The trade elasticity σ is a key parameter in the analysis, as it determines the extent of required (real) depreciation once the economy embarks on the escape path to full employment. Specifically, the rate of depreciation is higher the lower the trade elasticity, that is, as domestic and foreign goods becomes more complementary.

Which elasticity is relevant empirically? As is well known, there is little consensus in the literature. By and large, macro time-series estimates tend to yield values on the low side, ranging from as low as 0.3 to 2. Micro and trade estimates tend to yield much higher values, in the range of 2 to 4 or even higher.[17] There is nonetheless consensus that trade elasticities are not constant over different time horizons, prompting several studies to investigate the reasons for this difference (Ruhl (2008), Crucini and Davis (2016)). Specifically, trade elasticities are typically found to be low in the short run, but larger in the long run.

A.6.1 Escape under time-varying trade elasticities

In what follows, we construct a numerical example showing the implications for the escape path of letting elasticities differ as a function of time. In Figure 3, we set the elasticity just

---

[16]We assume that condition $\sigma > (1 - \omega)/(2 - \omega)$ holds throughout. If not, even though it still exists, the stagnation steady state becomes locally explosive, making it unappealing for further analysis.

[17]As regards macro studies, Taylor (1993) estimates the value for the U.S. to be 0.39, while Whalley (1984) reports a value of 1.5. For European countries most empirical studies suggest a value below 1. For instance, Anderton et al. (2004) report values between 0.5 and 0.81 for the Euro area. See the comprehensive study on G-7 countries by Hooper, Johnson and Marquez, 2000. As regards micro studies, for instance, Bernard et al. (2003) finds a value as high as 4.

above .45 at the beginning of the escape path, and increase it gradually to 3 as time passes. In turn, the other parameter values are as in Figure 1 in the main text. A number of striking results emerge. The exchange rate needs to adjust in nominal and real terms much more at the beginning of the transition, so does inflation. The real exchange rate actually overshoots its long-run value upfront, and appreciates during the transition. By implication, the real interest rate falls, implying that domestic saving temporarily rises. Most remarkably, despite the return of inflation to its target level, the nominal interest rate remains at the zero lower bound for some periods.

Our exercise suggests that, with time-varying elasticities along the escape route, the interest rate in a small open economy may remain at its zero-bound on impact even when the economy starts to recover. It may take some time before the improvement in macroeconomic conditions and persistent inflation allows the policy rate to return to positive territory. During the zero-bound spell, the economy actually experiences some exchange rate appreciation, after an initial overshooting of the currency's new equilibrium (depreciated) level.

A.6.2   A lower effective lower bound (ELB)

Reducing the effective lower bound (ELB) is irrelevant along the escape transitional dynamics as long as, along the path, the zero lower bound is never a binding constraint—as in Figure 1. It may be useful instead, in a scenario like the one depicted by Figure 3. With time-varying elasticities, the nominal rate may remain constrained at the ELB in the initial phase of the recovery. Once the economy is on this escape path, a reduction in the ELB allows a faster recovery, shortening the length of time in which monetary policy is constrained. Hence we complement our findings from Section 7.2, where we had argued that lowering the ELB may be counter productive in an economy open to asset trade as long as it finds itself in stagnation. Specifically, here we show that, once the economy is on the *escape path*, lowering the ELB may be useful as it speeds up the escape.
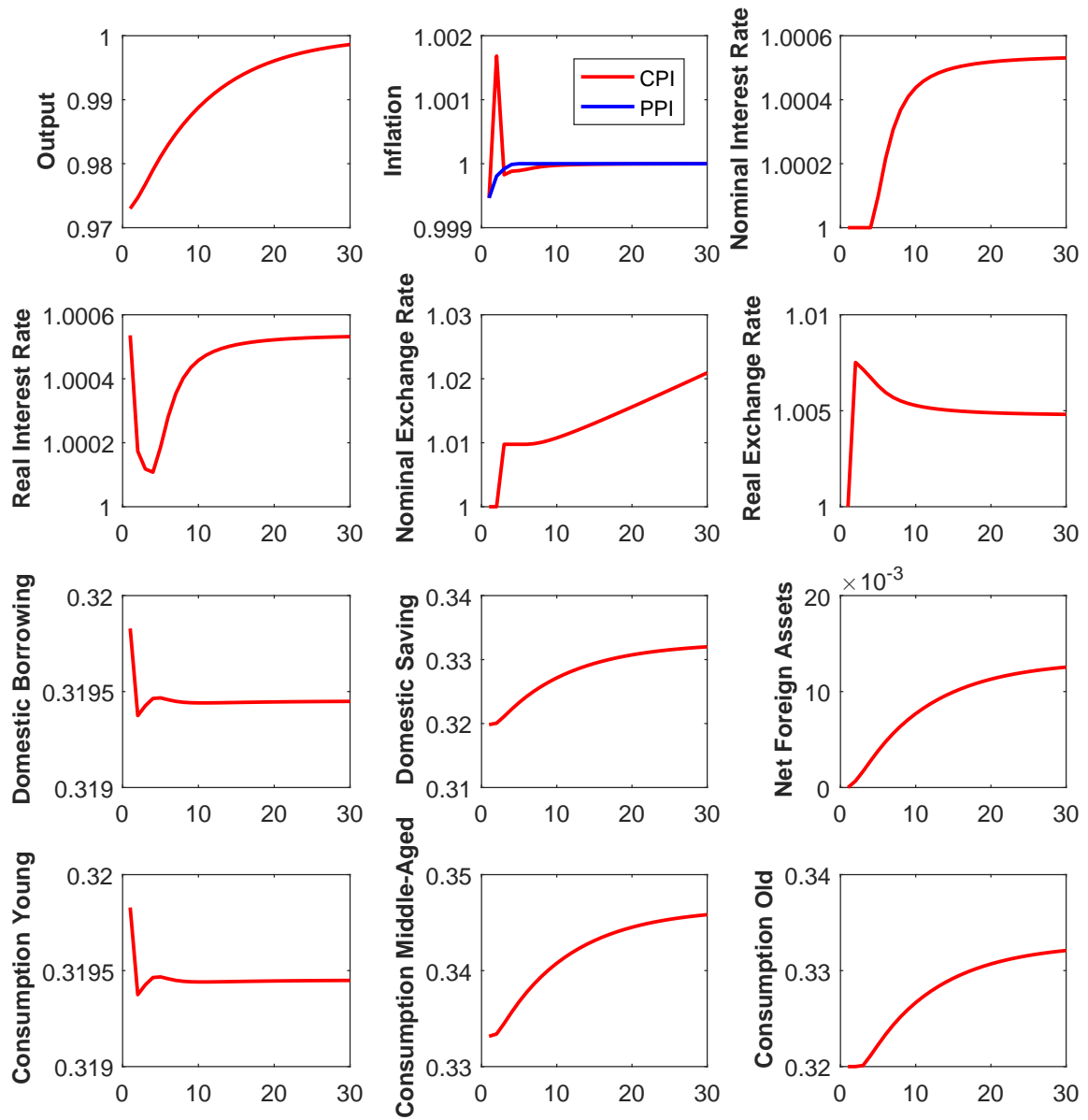
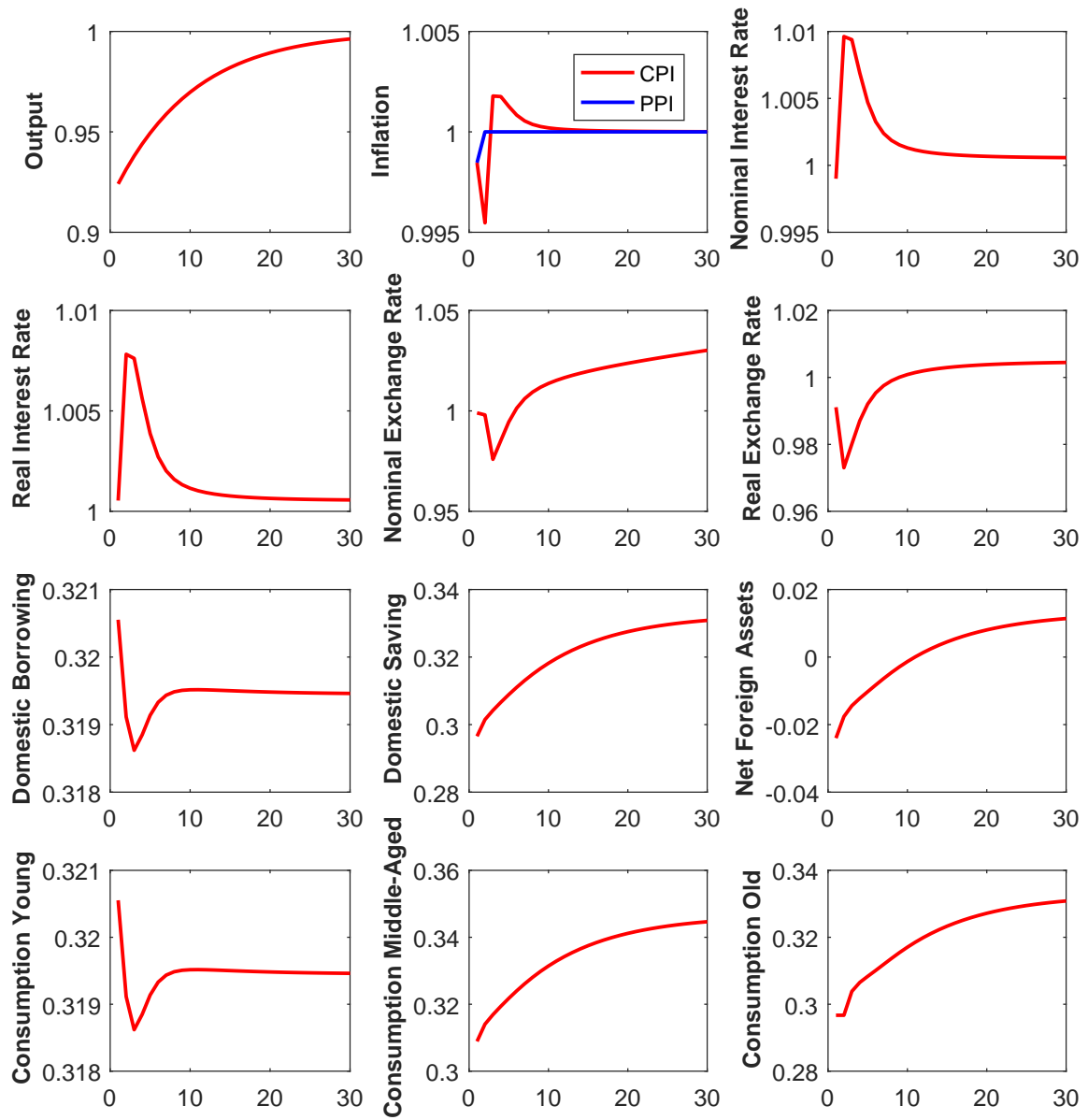Figure 3: Transition to full employment. Case of changing trade elasticity.

Figure 4: Transition to full employment as effective lower bound is reduced, $\bar{i}_{\text{ZLB}} = 0.01$. Case of changing trade elasticity.