Excess Savings and Twin Deficits:

The Transmission of Fiscal Stimulus in Open Economies

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Abstract

Three salient facts have emerged in the world economy since 2020. First, a large increase in private savings around the world, especially in the United States. Second, an increase in the current account deficit in the United States, with a corresponding surplus in the rest of the world. Third, a large increase in the fiscal deficit around the world, especially in the United States. In this paper, we argue that the third fact caused the first two. We do so in the context of a many-country heterogeneous-agent model in which deficit-financed fiscal transfers simultaneously lead to a large increase in private savings ("excess savings") and persistent current account deficits ("twin deficits"). Our model is also consistent with the distribution of U.S. checking account balances over this period: in the model and the data, a few quarters after a fiscal transfer, most of the excess savings are held by the rich. At this point, there is still a contribution to demand from spending down excess savings, but it is limited by the low marginal propensities to consume of the rich.

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1 Introduction

Since the onset of the Covid pandemic in early 2020, the world economy has experienced three salient macroeconomic facts.

Fact 1. *A large increase in private savings around the world, especially in the United States.*

Panel A of figure 1 shows that the private saving rate in the U.S. has increased from an annual average of 9% before the pandemic to 17% since. In our sample of 25 advanced economies making up the rest of the world, the saving rate rose from 6% to 11%. Many commentators have referred to this fact as "excess saving", often taking the view that the trend will soon revert. For instance, Emi Nakamura recently argued in an interview:[1]

> "households have a huge buildup in savings, and spending this down is no doubt contributing to demand."

Goldman Sachs (2021), TD Bank (2021) and European Central Bank (2021), among others, also argue that the rate at which excess savings are depleted is a critical question for the spending outlook in the coming years. Part of their argument is that Fact 1 was caused by an inability to spend due to pandemic-related restrictions, and that these restrictions are going away.

Fact 2. *An increase in the current account deficit and in the trade deficit in the United States, with a corresponding surplus in the rest of the world.*

Panel B of figure 1 shows that, after a long period of stability, the U.S. current account deficit and the trade deficit have both increased from 2% to almost 4% of GDP, with the rest of the world roughly absorbing these deficits. This phenomenon has also been widely discussed, and has also been argued to be related, among other things, to the change in spending patterns due to the pandemic.[2]

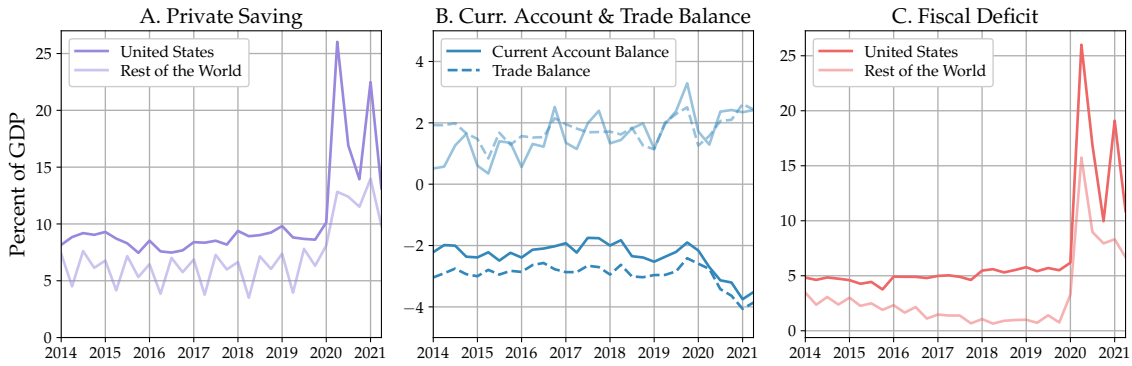
Fact 3. *A large increase in the fiscal deficit around the world, especially in the United States.*

Panel C of figure 1 shows that the U.S. fiscal deficit-to-GDP ratio grew from an average of 5% to 18%, while in the rest of the world it grew from 2% to 9%. Around the world, these fiscal deficits were largely used to finance transfers to households and firms to cushion the blow of the pandemic.[3]

[1] See Noahpinion, "Interview: Emi Nakamura, macroeconomist", Feburary 21, 2022.

[2] See for instance New York Times, "The U.S. trade deficit soared to a record last year", February 8, 2022.

[3] Congressional Budget Office (2020) and IMF Fiscal Affairs Department (2021) show that fiscal deficits were largely used to finance furlough pay, extended unemployment insurance benefits, stimulus checks, and so on.



For this graph, "Rest of the World" consists of 16 advanced economies, as listed in Appendix Table 3. Sources: U.S. National Income and Product Accounts, IMF International Financial Statistics, and OECD Quarterly Sector Accounts.

Figure 1: Three salient facts

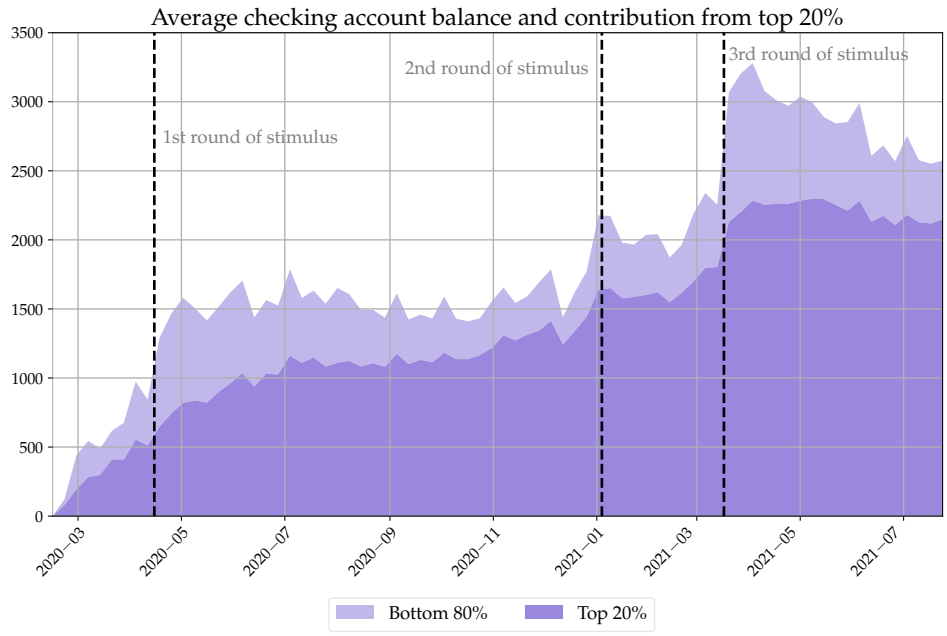
In this paper, we argue that these three facts are intimately connected. We propose a model in which Fact 3 is the *sole* cause of both Facts 1 and 2. Our model rationalizes both the timing and the magnitude of the excess saving and the current account patterns observed since 2020 as effects of the worldwide fiscal policy response to the pandemic, rather than effects of the pandemic per se.

While we are not the first to argue that fiscal policy has played a role in explaining the increase in savings and the trade deficit, we go beyond what others have said by, first, showing that pandemic restrictions are *not necessary* to explain the observed savings, and second, by showing that the observed small magnitude and delay in the current account deficit are consistent with a "slow-motion" version of the so-called "twin deficit" hypothesis—one in which home bias and delayed spending play a critical role in transmitting a fiscal deficit to a current account deficit.

Our model captures the following story. Countries around the world used fiscal deficits to finance transfers to households. Households partly spent these transfers according to their marginal propensities to consume (MPC), and initially saved the rest.[4] This explains the build-up of excess savings (Fact 1). Current account deficits emerged because part of the spending was on imported goods (Fact 2). But because, in relatively closed countries like the United States, the share of imported goods is small, the initial impact of this spending on the current account deficit was also small.

Critically, consistent with the arguments from Nakamura and others, households' excess savings remain available to be spent. Some fraction of this spending goes into imports, too, prolonging the current account deficit. In other words, it is because of excess

[4] Coibion, Gorodnichenko and Weber (2020), Ganong, Greig, Liebeskind, Noel, Sullivan and Vavra (2021) and Parker, Schild, Erhard and Johnson (2022) document that households saved a significant faction of their stimulus checks.



Source: JPMorgan Chase Institute. The graph shows the average checking account balance relative to the first week of 2020, and the contributions to this mean from the top 20% and the bottom 80% of the distribution of balances. These contributions are estimated from information about the 25, 50, 75 and 90th percentiles by fitting a spline through the cumulative distribution function. These percentiles are reported here. We thank Erica Deadman, Peter Ganong, Fiona Greig and Pascal Noel for sharing the data.

Figure 2: Increase in mean checking account balance and contribution from the top 20%

savings (Fact 1) that the effect on the current account balance takes place in slow motion.

While spending on imported goods draws down excess savings, spending on domestic goods does not. This is because the latter also appears as increased income of the private sector. Moreover, for the world as a whole, even expenditure on imports is income, so household spending cannot deplete *worldwide* excess savings. Instead, while households in each country try to spend down their savings, they receive income from the rest of the world. On balance, savings only decline in countries where households received larger-than-average transfers. It is therefore in those countries that a current account deficit emerges (Fact 2).

We develop a world-economy Heterogeneous-Agent New-Keynesian model that formalizes this narrative. The model is a merger of two heterogeneous-agent models from previous work: the closed-economy fiscal policy model in Auclert, Rognlie and Straub (2018), and the open-economy model in Auclert, Rognlie, Souchier and Straub (2021c)—itself a heterogeneous-agent version of the Galí and Monacelli (2005) model. Our model has three key features.

First, households have buffer-stock behavior: in response to a fiscal transfer that raises their wealth above target, they try to spend down the additional wealth over time. Because MPCs are declining in wealth, the poor spend down faster than the rich—consistent

with figure 2, which shows that middle class households (as proxied by the bottom 80% of the distribution of cash balances) rapidly depleted the excess checking account balances they built from each of the three rounds of stimulus payments.[5] Second, in line with the data, the model has open economies with substantial home bias in spending. Third, going beyond the Galí and Monacelli (2005) small-open-economy assumption, domestic fiscal policy can affect the worldwide demand for goods as well as world interest rates.

We use our model to study the consequences of a country, or set of countries, conducting transfers financed by a permanent increase in their debt level. A permanent increase seems a good approximation to what will happen to debt levels as a result of the pandemic. In most of our analysis, we assume that the real interest rate on government debt starts at $r = 0$—a reasonable long-term value for advanced economies, which also makes theoretical results especially tractable.

We start by considering a small economy, such that the fiscal expansion does not affect world aggregates. We prove a stark result: in the long-run natural allocation, there is no excess savings, and cumulatively there is a perfect twin deficit—the net foreign asset position of the country deteriorates one for one with the increase in public debt. The intuition is simple: at $r = 0$ and in a small economy, the fiscal expansion does not require raising taxes, and it does not affect the world interest rate. This leaves long-run asset demand by domestic households unchanged, implying that the rise in domestic asset supply must be financed from abroad.[6]

The short run is quite different. Initially, most of the transfers show up as excess savings, since households only spend a fraction of their transfers, and only part of this spending is on foreign goods. To take a simplified example, imagine that households receive a transfer of \$100 and have an MPC of 0.25. If the foreign spending share α is 10%, then only $\$100 \times 0.25 \times 10\% = \$2.50$ of the transfer will initially appear as a current account deficit. Of the remaining \$97.50, \$75 is saved, while \$22.50 is spent on domestic goods, which appears as domestic income and hence offsets the cost of the spending. Hence private savings increase by \$97.50, absorbing the vast majority of the initial transfer.

This simplified calculation, however, ignores the fact that when domestic income endogenously increases, households will spend a fraction of that as well. It also ignores what will happen in subsequent periods, as households are left with substantial excess savings on their balance sheets, which they attempt to spend down. We capture both these forces by deriving analytical expressions for the full first-order general-equilibrium

[5] See also New York Times, "Americans' Pandemic-Era 'Excess Savings' Are Dwindling for Many", December 7, 2021.

[6] The logic for this result is very general and holds for any model with imperfectly elastic asset demand at $r = 0$ (the case with $r \neq 0$ is quantitatively very similar).

dynamics of the current account and private savings in response to a change in the path of fiscal deficits. These expressions require only knowledge of openness α and the matrix $\mathbf{M}$ of "intertemporal MPCs" (a generalization of the static MPC concept, see Auclert et al. 2018), and they confirm our example: with small α and reasonable $\mathbf{M}$, excess savings initially absorb the vast majority of transfers, and are depleted only slowly by current account deficits.[7]

Underlying these aggregate dynamics are distributional dynamics that echo figure 2. Initially, after they receive transfers, middle-class households are responsible for roughly half of excess savings. But since their MPCs are higher, their savings dissipate more quickly, and we enter a second stage of the transition, where excess savings are mainly held by the domestic rich. Eventually—though, with low openness α and low MPCs of the rich, this is a slow process—we enter the third stage, where excess savings dissipate and a perfect twin deficit emerges, in line with our long-run result.

We next turn to the world economy, allowing for fiscal expansions in every country. We prove that in relative terms, countries in the world economy have the same short- and long-term outcomes that we have already characterized for small economies. At first, therefore, countries with larger fiscal expansions have correspondingly larger excess savings. In the long run, however, these countries' larger excess savings are depleted by larger current account deficits, until all countries have equal excess savings. These theoretical results are qualitatively consistent with our three facts: large fiscal interventions worldwide (Fact 3) produce large excess savings everywhere (Fact 1), as well as smaller but prolonged current account deficits in the largest-intervention countries (Fact 2).

We finally develop a quantitative version of the model to evaluate its fit to the Covid episode. We show that our model, once calibrated to observed openness and MPCs, accurately predicts the cross-country relationships between current account deficits, private savings, and fiscal deficits. We then use the model to evaluate the counterfactual effect of fiscal policy during this episode, both in the past and the future. Echoing our theoretical results, we find that in the long run, the counterfactual effect on net foreign asset positions is approximately equal to the opposite of each country's increase in debt-to-GDP relative to the world. Applied to the heterogeneous fiscal expansion during the Covid episode, this implies a 10pp. improvement in the NFA-to-GDP ratio of Denmark and a 2pp. deterioration in the US. These are relatively small because the fiscal expansion was fairly uniform. The transition is slow, with a half-life of 5 years.

In addition, our model recovers the *level* effect of the fiscal policy intervention alone.

[7] Although these formulas are derived assuming that monetary policy holds real interest rates constant, we show quantitatively that other monetary rules deliver very similar paths.

This involves an 80bp increase in the real interest rate (which we assume monetary authorities around the world accommodate by increasing the intercept in their Taylor rules), an annualized rate of inflation of 4% for 2022, and a 2–3% output boom for 2021 and 2022 in most countries, with larger-expansion countries experiencing higher inflation, output, and a more appreciated real exchange rate.

In sum, the fiscal intervention (Fact 3) naturally explains Facts 1 and 2. Could some other shock, presumably related to Covid, also explain these same facts? One popular hypothesis is that the pandemic led households to lower their desired spending, causing an increase in private savings irrespective of fiscal policy. We argue that this is implausible, for three reasons. First, we note that absent fiscal deficits, from an accounting perspective an increase in worldwide savings is only possible through an increase in worldwide investment. The required magnitude of such a rise in investment is implausible (i.e. a surge in net investment from 5% to 25% of GDP, when in practice it fell).

Second, this hypothesis suggests that countries with greater Covid severity or more widespread lockdowns should have seen larger increases in private savings. We document in cross-country regressions, however, that these effects are roughly zero in the data.[8] By contrast, the relationship between fiscal deficits and savings is strongly positive, with a slope mildly below 1 and consistent with our model.

Finally, we can use our model to study the effects of a shock that depresses desired spending in a country. In general equilibrium, such a shock decreases domestic income as well, and its effect on savings depends on whether it reduces income by more or less than spending. We implement two versions of this shock: a shock to overall desired spending on all goods, and a shock to desired spending on domestic goods (consistent with the large reduction in service sector demand). We find that the first shock leads to only a small increase in savings, on the order of 1% when scaled to match the observed decline in GDP; and that the second shock actually leads to a *decline* in savings.

Related literature. Previous work has argued that, in an accounting sense, fiscal policy was responsible for the boost in disposable income, and therefore for some of the excess savings observed in the United States and elsewhere (see, for instance, TD Bank 2021, and European Central Bank 2021). But this work has also argued that pandemic restrictions were important, because they depressed consumption. We argue that this effect disappears in general equilibrium: restrictions that depress consumption also depress income, so that the effect on private saving is small at best.

[8]There is zero correlation in the data between lockdown severity and excess savings, and if anything a slight negative cross-country correlation between Covid deaths and savings. Adding controls does not change these results.

Some commentators have also linked the recent U.S. current account deficit to the fiscal deficit, mentioning that this was an instance of the classical "twin deficit" hypothesis. But they have noted a puzzle about the magnitude: the increase in the U.S. current account deficit has been small relative to the increase in the fiscal deficit.[9] There is an even larger puzzle about the timing: while the fiscal deficits mostly occurred in 2020, the U.S. current account deficit has continued through 2022. Our model can explain both the small magnitude and the slow-motion effect.

The twin deficit hypothesis, according to which fiscal deficits cause current account deficits, was popular in the 1980s, when the Reagan tax cuts were followed by a large appreciation of the dollar and a large increase in the current account deficit, consistent with the predictions of a static Mundell-Fleming model (e.g. Feldstein 1993, Ball and Mankiw 1995). It then fell out of fashion in the 1990s and 2000s, since the Clinton years featured both a fiscal surplus and a current account deficit—a so-called "twin divergence".

Empirically, Bernheim (1988), Chinn and Prasad (2003), and Chinn and Ito (2007) find a generally positive correlation between fiscal deficits and current account deficits in a panel of countries. But it is well understood that the data is driven by many shocks beyond fiscal policy shocks.[10] More recent work using identified tax shocks has reached mixed conclusions: using a structural VAR, Kim and Roubini (2008) find evidence for "twin divergence", while, using narratively-identified tax shocks, Feyrer and Shambaugh (2012) and Guajardo, Leigh and Pescatori (2014) find evidence for the causal twin deficit hypothesis. Our empirical section looks at the Covid recession as a new episode to study this causal effect, exploiting large cross-country variation in fiscal deficits while controlling for the size of the Covid shock.

On the theory side, there are three classic types of models of the macroeconomic response to deficit-financed transfers. A frequent starting point is the Ricardian equivalence hypothesis (Barro 1974), according to which these transfers cause excess savings and have no other macroeconomic consequence, except to the extent that taxes are distortionary. Non-Ricardian models with hand-to-mouth agents a la Galí, López-Salido and Vallés (2007), Bilbiie (2008), Farhi and Werning (2016) imply some twin deficits, but, as explained in Bilbiie, Eggertsson and Primiceri (2021), these occur only contemporaneously with the fiscal deficit, with excess savings sticking around forever after that: in these models, anyone who spends out of excess savings does so immediately. Our model has less selection into the set of spenders and therefore predicts a much more prolonged effect.

[9] See Jason Furman, https://twitter.com/jasonfurman/status/1440315145918447631 and https://twitter.com/jasonfurman/status/1440397123099324422.

[10] For instance, a business cycle boom typically is associated with a current account deficit as import demand rises, as well as a fiscal surplus due to higher tax revenue and reduced transfer payments.

The finite-horizon Blanchard (1985) model and its descendants (e.g. Ghironi 2006 and Kumhof and Laxton 2013), on the other hand, behave more similarly to ours. Blanchard (1985) pointed out the long-run deterioration of the NFA in response to a permanent increase in the debt, and the fact that there was a transition, but he overstated the speed of this transition for two reasons. First, in his model there is no selection of the set of spenders at any point in time. Second, and more importantly, he worked with a model with no home bias.

Our paper also contributes to the Heterogeneous-Agent New Keynesian literature. This literature started out mostly studying monetary policy in closed economies (McKay, Nakamura and Steinsson 2016, Kaplan, Moll and Violante 2018, Auclert 2019, Werning 2015), and has since studied fiscal policy in closed economies (Auclert et al. 2018, Hagedorn, Manovskii and Mitman 2019) and monetary policy in open economies (Auclert et al. 2021c, Guo, Ottonello and Perez 2021).[11] To our knowledge, we are the first paper to study fiscal policy in open economies in this class of models.[12]

Layout. The rest of the paper is structured as follows. Section 2 presents empirical evidence on the cross-country determinants of excess savings and current account deficits, pointing to fiscal deficits as a key explanation. Section 3 sets up the model. Section 4 proves results about twin deficits in the long-run and the short-run, examines the role of MPCs and openness, and shows that the asset distribution dynamics are consistent with the data. Section 5 analyzes the world economy model and proves that its solution separates into a deviation and an average component. Finally, Section 6 conducts our counterfactual analysis.

2 Cross-country evidence

In this section, we begin by substantiating our Facts 1–3 across a set of 26 advanced economies. We construct four country-level measures—excess saving, excess current account deficits, excess investment, and excess fiscal deficits—and visualize their evolution during the Covid pandemic. Based on the balance of payments identity, we then decompose excess fiscal deficits into the other three measures. We use the decomposition to argue that fiscal deficits are an important driver of the cross-country variation in excess saving and current account deficits, while other elements related to the magnitude of the

[11] See also de Ferra, Mitman and Romei (2020), Oskolkov (2021), and Zhou (2022).

[12] See House, Proebsting and Tesar (2020) for a study of fiscal policy in a many-country model with hand-to-mouth agents.

Covid shock have much less explanatory power.

2.1 Excess savings, current accounts, and fiscal deficits across countries

We focus on advanced economies as classified by the IMF. These economies are a natural starting point for our analysis because they constitute a large and highly financially integrated part of the world (as recently emphasized by Rachel and Summers 2019).

For advanced economy k, we collect data on (net) private saving PS_t^k, the current account CA_t^k, the fiscal deficit FD_t^k, and GDP Y_t^k over the period 2014Q1–2021Q2. Private saving is constructed by subtracting depreciation from gross private saving in the OECD Quarterly Sector Accounts, and the other three variables are from the IMF International Financial Statistics database. 28 advanced countries have both current account and fiscal deficit data for the entire period. We exclude Ireland and Norway, whose current accounts are known to be heavily influenced by tax haven flows and oil and natural gas prices, respectively. This determines our baseline set of 26 countries.

We also defined a reduced set of countries that have all balance of payment data, as follows. 18 countries of our baseline set also have private saving data, and of these, 17 also have investment data.[13] This leaves us with a reduced sample of 17 countries. Appendix A lists all the countries in our baseline and reduced sample, and provides more details about the variables we use. We refer to the set of remaining 16 advanced economies in the reduced sample, excluding the U.S., as the "Rest of the World".

The main three measures we compute across countries are constructed as follows. First, we define "excess savings" as the accumulated stock of assets from private saving above the pre-Covid trend. Taking $t = 0$ to be 2020Q1, we define for any quarter $t \geq 1$:

$$\text{Excess Private Savings}_t^k \equiv \sum_{s=1}^{t} \left(\frac{PS_s^k}{Y_0^k \left(1 + \overline{g^k}\right)^s} - \overline{\left(\frac{PS}{Y}\right)^k} \right) \tag{1}$$

where $g_t^k \equiv \frac{Y_{t+1}^k}{Y_t} - 1$ is nominal GDP growth, and bars denote the 5 year pre-pandemic average (2015Q2-2020Q1).[14] Similarly, we define cumulative "excess current account sur-

[13] Countries for which we are missing saving data make up a relatively small fraction of advanced economy GDP: Cyprus, Estonia, Iceland, Latvia, Lithuania, Luxembourg, Malta, and Slovakia. Among the remaining countries, Belgium has missing investment data.

[14] We rebase the level of private savings using potential GDP $Y_0^k \left(1 + \overline{g^k}\right)^s$ rather than actual GDP Y_s^k to avoid the mechanical effect of the recession on the savings-to-GDP ratio.

pluses" and "excess fiscal deficits":

$$\text{Excess Current Accounts}_t^k \equiv \sum_{s=1}^{t} \left(\frac{CA_s^k}{Y_0^k \left(1+\overline{g^k}\right)^s} - \overline{\left(\frac{CA}{Y}\right)^k} \right) \tag{2}$$

$$\text{Excess Fiscal Deficits}_t^k \equiv \sum_{s=1}^{t} \left(\frac{FD_s^k}{Y_0^k \left(1+\overline{g^k}\right)^s} - \overline{\left(\frac{FD}{Y}\right)^k} \right) \tag{3}$$

These three excess metrics effectively capture the additional stock of private wealth, the additional net foreign asset position, and the additional public debt, all relative to potential GDP, that countries have incurred up until quarter t.[15]

Figure 3 displays these metrics across countries for the period from 2020Q1 to 2021Q2 ($t = 5$), the latest quarter for which all data is available. Our three facts are clearly apparent: by 2021Q2, excess savings amounts to about 12% of GDP in the U.S. (7% in the rest of the world), the cumulative current account deficit is about 1.5% (0.5% surplus for the rest of the world), and excess fiscal deficits are about 13% (9% for the rest of the world). Our fiscal deficit measure lines up well with an independent measure of the fiscal response to Covid by the IMF.[16]

2.2 Accounting for fiscal deficits

The balance of payments identity relates our three measures in a natural way: at the level of a country, the difference between private saving, the current account and the fiscal deficit must be equal to net investment I_t (modulo the statistical discrepancy):

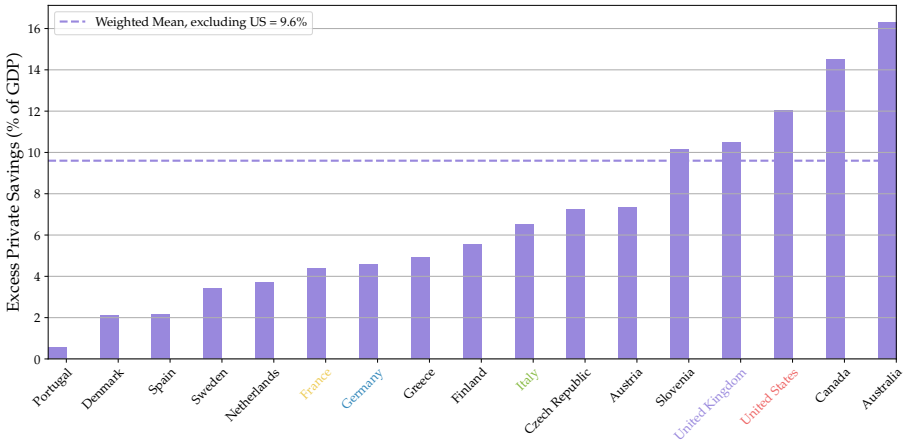
$$PS_t - CA_t - FD_t = I_t \tag{4}$$

This suggests that our three facts are not complete without examining the cross-country pattern of net investment. We construct net investment from the OECD as gross invest-

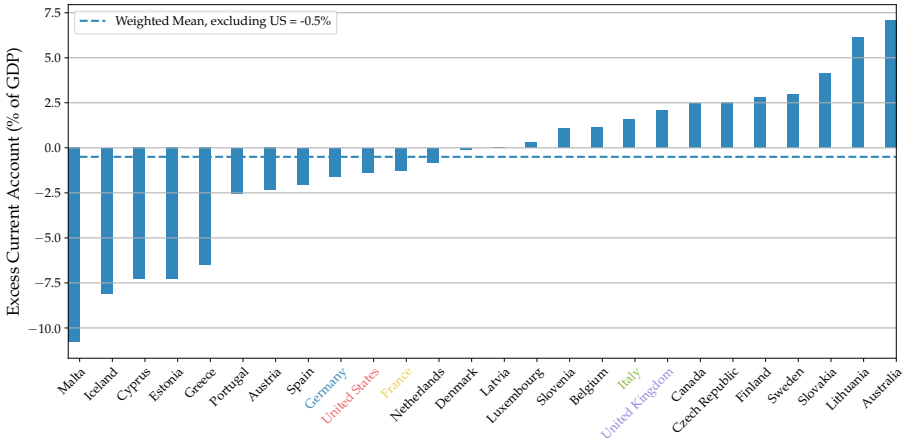
[15] While all three stocks in principle could be measured directly, in practice measured wealth-to-GDP and NFA-to-GDP ratios are heavily influenced by valuation effects (Saez and Zucman 2016, Gourinchas and Rey 2007, Atkeson, Heathcote and Perri 2022). Our metric of excess savings corresponds more directly to the increase in wealth that resulted from additional saving by private agents, rather than from changes in the prices of the assets they held.

[16] Source "Fiscal Policies Database in Response to COVID-19", entry "Additional spending or foregone revenues in non-health sector, as % of GDP, covering measures for implementation in 2020, 2021, and beyond."

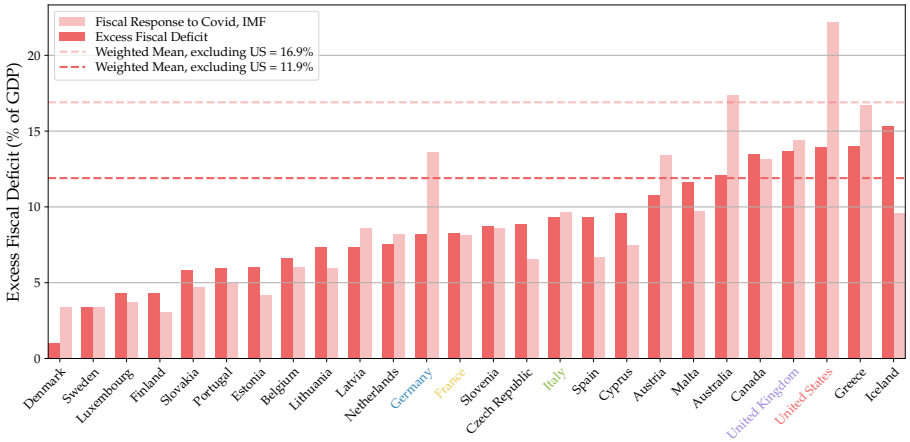
Fact 1: Large increase in private savings around the world, especially in the U.S.



Fact 2: Increase in the current account deficit in the U.S., surplus in rest of the world



Fact 3: Large increase in fiscal deficits around the world, especially in the U.S.



Source: IMF International Financial Statistics and Fiscal Policies Database in Response to COVID-19, OECD Quarterly Sector Accounts, and author's calculations.

Figure 3: Facts 1–3 across 26 advanced economies (2020Q1 to 2021Q2)

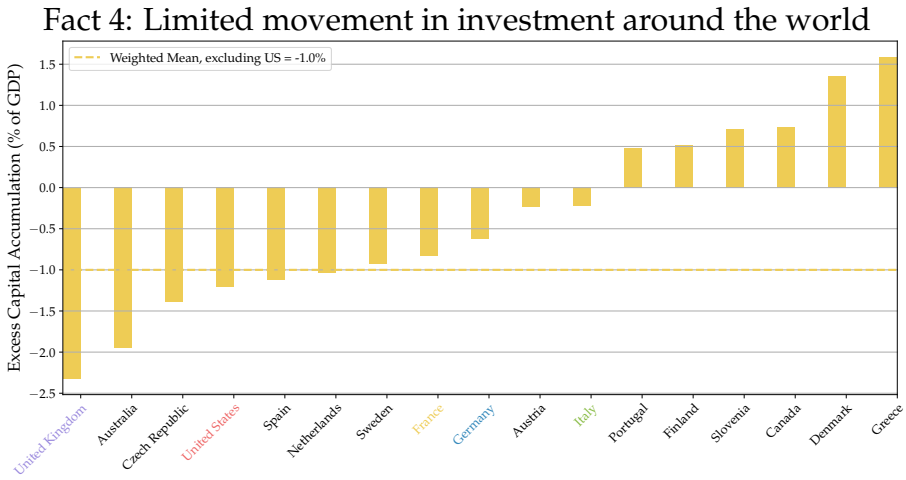


Figure 4: Excess capital accumulation across 17 economies in our reduced sample

ment net of depreciation, and cumulate deviations from the pre-Covid trend as in (1)–(3):

$$\text{Excess Capital Accumulation}_t^k = \sum_{s=1}^{t} \left(\frac{I_s^k}{Y_0 \left(1 + \overline{g^k}\right)^s} - \overline{\left(\frac{I}{Y}\right)^k} \right)$$

Figure 4 shows "excess capital accumulation" between 2020Q1 and 2021Q2 across countries. On average in the sample, excess capital accumulation is negative, and in general it exhibits limited cross-country variation. This leads us to a fourth fact:

Fact 4. *Limited movement in net investment around the world.*

Fact 4 is important because, in conjunction with our other facts, it points to fiscal policy as a potent driver of private saving:

$$PS_t = FD_t + CA_t + I_t \tag{5}$$

Equation (5) suggests that, given limited movement in net investment and the current account, large private saving must come together with large fiscal deficits. The critical question, then, is if a causal mechanism relates the two. We explore this question in great detail in the context of our model below.

Equation (5) also shows that any attempt at explaining large private saving without relying on fiscal deficits must rely on either a large current account surplus or a large increase in investment. Since current account balances must net out for the world as a whole, the only way to get an increase in *worldwide* saving is through an increase in worldwide investment. To explain the the magnitude of the worldwide savings increase,

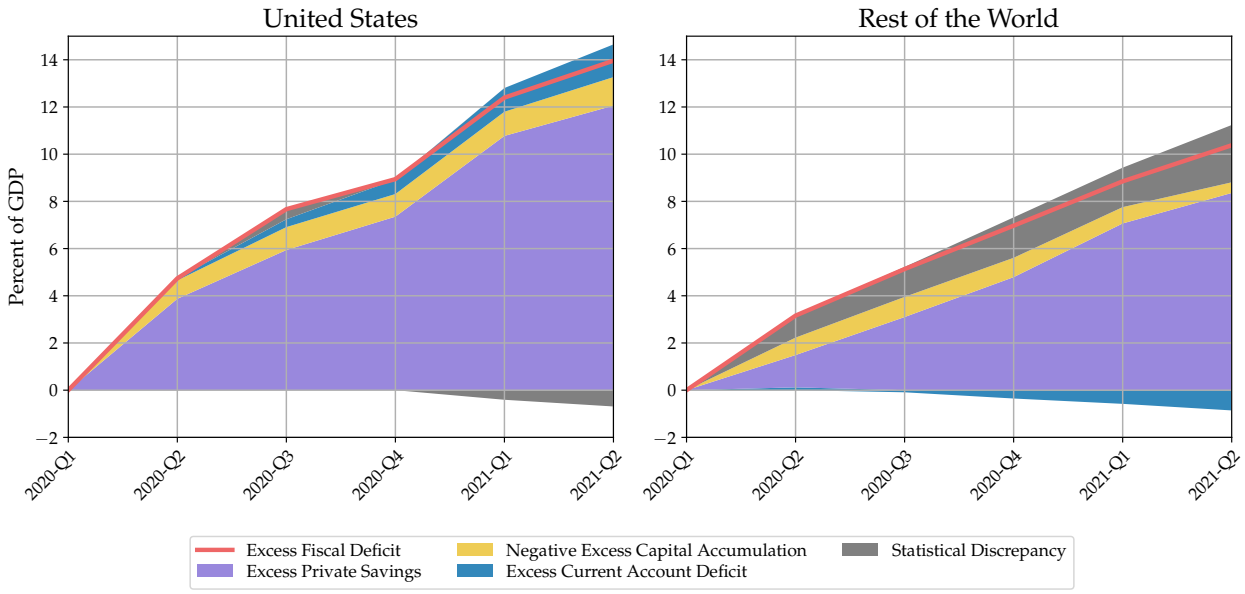


Figure 5: Accounting for fiscal deficits in the United States and the Rest of the World

the counterfactual increase in investment would have to be implausibly large—a surge in net investment from 5% to 12% of GDP—when figure 4 shows that net investment fell both worldwide.

Since we have argued that excess fiscal deficits mainly reflect countries' discretionary responses to Covid, a final natural way of writing the accounting identity in (4) is as $FD_t = PS_t - CA_t - I_t$. Since this equation holds in every time period, we also have:

$$\begin{aligned} &\text{Excess Fiscal Deficits}_t^k = \text{Excess Private Savings}_t^k \\ &-\text{Excess Current Accounts}_t^k - \text{Excess Capital Accumulation}_t^k \end{aligned} \tag{6}$$

Equation (6) provides us with a natural decomposition of excess fiscal deficits, showing how each of the components of the balance of payments adjusts to accommodate these deficits. Figure 5 performs this exercise for the U.S. and the Rest of the World: at each quarter t, it shows how much of the fiscal deficit was empirically accounted for by private saving, investment and the current account. These graphs suggest that private saving accounted for the most, that current account deficits are smaller and more delayed, and that investment moved little. Figure 19 in the appendix reproduces this graph separately for all the 16 "Rest of the World" countries in our sample. We come back to these patterns in section 6.

2.3 Cross-country determinants of excess savings and current accounts

The evolution in figure 5 points to a causal mechanism, from fiscal deficits to saving and current account deficits. To explore this mechanism, we correlate the three variables on the right hand side of (6) with excess fiscal deficits across countries. An alternative story is that the Covid shock itself is what caused excess savings (e.g. as households were not able or willing to spend as much as before) and/or current account deficits (e.g. as households shifted their spending away from services towards goods). We explore this alternative story by correlating the three variables on the right hand side of (6) with measures of Covid and lockdown severity.

The first column of figure 6 considers our claim that the fiscal deficit explains these patterns, the middle and right columns consider the alternative "Covid shock" hypothesis using two metrics of Covid intensity: a lockdown index (where 0 indicates laxest and 100 strictest) and the cumulative number of deaths per thousand individuals.[17]

The figure shows that fiscal deficits provide a powerful explanation for excess savings: across countries, the "pass-through" after 5 quarters is about 0.8, and is precisely estimated. In other words, an increase in the fiscal deficit of 10% leads to an increase in excess savings of 8%. Moreover, the pass-through to the current account is -0.35, which points to a substantial "twin deficit" after 5 quarters already.[18]

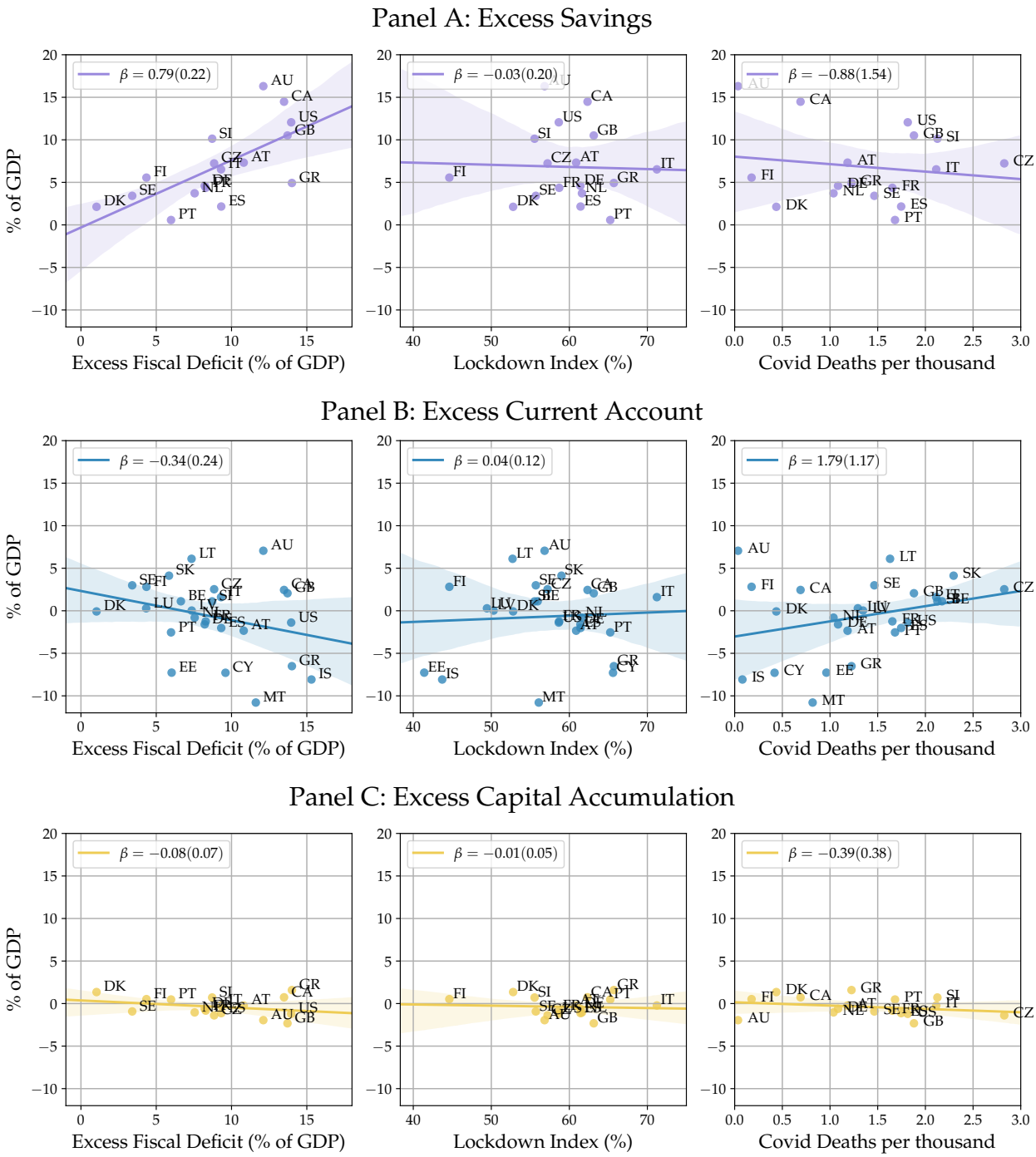
By contrast, the figure shows that the Covid shock story has a difficult time explaining the cross-section of excess savings. The lockdown has no association with savings, with a point estimate of zero. Covid deaths correlate with the wrong sign: an increase in deaths by 2 per thousand, from the Finnish to the Italian level, reduces excess savings by 2%. Similarly, lockdowns and Covid deaths have a difficult time explaining the cross-section of current accounts: the point estimates are positive but insignificant.[19]

While these are raw regression coefficients, in figure 18 in the appendix we show that these facts hold up almost identically if we residualize each of our explanatory variables by the other two.

[17] The lockdown index is "a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100". Covid deaths per thousand are cumulated between 2020Q1 and 2021Q2. Source: Our World in Data stringency index and covid deaths.

[18] Given (6), the coefficients on private savings, minus those on capital accumulation and current accounts must be 1. This is not exactly true in figure 6 because we have more countries with data on current accounts.

[19] Investment also has very limited association with either fiscal deficits or covid severity. Motivated by these results, model abstracts away from it altogether.



Note: β indicates the regression coefficient of the y-axis on the x-axis variable. The standard error around this coefficient is in parentheses. Shaded areas correspond to 68% boostrapped confidence intervals.

Figure 6: Cross-country determinants of excess savings, investment, and current accounts

3 Model

We now describe our many-country HANK model. The general structure of the model is borrowed from Galí and Monacelli (2005)'s small-open economy, representative-agent New Keynesian model. We add three elements to this model. First, as in Auclert et al. (2021c), in each country there are heterogeneous agents facing idiosyncratic income uncertainty and borrowing constraints. Second, as in Auclert et al. (2018)'s closed-economy model, agents are taxed according to a progressive tax schedule, and the government conducts fiscal policy by changing transfers, purchasing local goods, and issuing or retiring public debt. Finally, an innovation of this paper is to modify the Galí and Monacelli (2005) environment to consider an integrated world economy made of any number of countries, interacting in frictionless capital markets but subject to home bias in spending. Asset market clearing at the world level is essential to understand the implications of a worldwide fiscal expansion, such as the one we consider in our application to the Covid fiscal shock.

We write down the model by assuming that individuals have perfect foresight over aggregate variables, and solve the model to first order in these aggregates. As Auclert, Bardóczy, Rognlie and Straub (2021a) show, this solution is identical to the first-order perturbation solution of the equivalent model with aggregate shocks.

World economy setup. There are K countries. Consumption c_{it}^k of consumer i in country $k = 1 \dots K$ aggregates a "home" good H, produced by country k itself, and a "world" good W, made up of goods produced by all countries. The elasticity of substitution between the home and the world good is η, with $1 - \alpha^k$ measuring the extent of home bias in consumption:

$$c_{it}^k = \left[\left(1 - \alpha^k\right)^{\frac{1}{\eta}} \left(c_{iHt}^k\right)^{\frac{\eta-1}{\eta}} + \left(\alpha^k\right)^{\frac{1}{\eta}} \left(c_{iWt}^k\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \tag{7}$$

The world good basket W is common to all countries and given by:

$$c_{iWt}^k = \left(\sum_{l=1}^{K} \left(\omega^l\right)^{\frac{1}{\gamma}} \left(c_{iWt}^{k,l}\right)^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \tag{8}$$

We assume that $\gamma > 0$, $\eta > 0$, $\omega^l \geq 0$, and $\sum_{l=1}^{K} \omega^l = 1$. Note that the weights $\{\omega^l\}$ are the same in each country k.

Domestic agents. We now describe the domestic economy in any given country k. To simplify notation, we call that country "home" and drop the superscript k whenever there is no ambiguity. Home households have preferences over home and world goods described by equation (7). They work hours N_t at disutility $v(N_t)$, but take these hours as given in the short run. A union occasionally resets their nominal wage W_t, denoted in home currency. Households invest in a mutual fund asset with nominal value A subject to a borrowing constraint, which we assume to be equal to zero for simplicity. This asset pays a real return r_t^p in terms of the consumer price index P_t, denoted in home currency. Households are also subject to a CPI-indexed tax schedule a la Heathcote, Storesletten and Violante (2017), with intercept ν_t and degree of progressivity λ. Their Bellman equation is therefore:

$$\begin{aligned} V_t(A,e) \quad &= \quad \max_{c_F,c_H,a'} u\left(c\left(c_H,c_W\right)\right) - v\left(N_t\right) + \beta \mathbb{E}_t\left[V_{t+1}\left(A',e'\right)\right] \\ &\text{s.t.} \quad P_{Ht}c_H + \sum_{l=1}^{K} P_{lt}c_W^l + A' = \left(1+r_t^p\right)\frac{P_t}{P_{t-1}}A + P_t \cdot \nu_t \left(e\frac{W_t}{P_t}N_t\right)^{1-\lambda} \\ &\qquad A' \geq 0 \end{aligned} \tag{9}$$

where $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, with $c\left(c_H,c_W\right)$ described in (7), and $v(n) = \varphi\frac{n^{1+\phi}}{1+\phi}$. We define aggregate real post-tax income as the cross-sectional average:

$$Z_t \equiv \mathbb{E}_e\left[\nu_t\left(e\frac{W_t}{P_t}N_t\right)^{1-\lambda}\right]$$

Since labor is not a choice, Z_t is taken as given by the household. Defining $a = \frac{A}{P_{t-1}}$ as the real value of household assets, and using standard two-step budgeting arguments with CES utility, we can solve for policy functions as follows. First, rewrite equation (9) as:

$$\begin{aligned} V_t(a,e) \quad &= \quad \max_{c,a'} u(c) + \beta \mathbb{E}_t\left[V_{t+1}\left(a',e'\right)\right] \\ &\text{s.t.} \quad c + a' = \left(1+r_t^p\right)a + \frac{e^{1-\lambda}}{\mathbb{E}\left[e^{1-\lambda}\right]}Z_t \\ &\qquad a' \geq 0 \end{aligned} \tag{10}$$

The solution to this problem gives households' optimal choice of consumption vs savings for given aggregate sequences $\left\{r_t^p, Z_t\right\}$. Denote by $c = c_t(a,e)$ the resulting consumption policy. Then, the demand for home goods (respectively, for country l goods) for a

household in state (a, e) is given by:

$$c_{Ht}(a,e) = (1-\alpha)\left(\frac{P_{Ht}}{P_t}\right)^{-\eta} c(a,e) \qquad c^l_{Wt}(a,e) = \alpha\omega^l\left(\frac{P_{lt}}{P_{Wt}}\right)^{-\gamma}\left(\frac{P_{Wt}}{P_t}\right)^{-\eta} c(a,e)$$

where $P_t = \left[(1-\alpha)(P_{Ht})^{1-\eta} + \alpha(P_{Wt})^{1-\eta}\right]^{\frac{1}{1-\eta}}$ is the consumer price index and $P_{Wt} = \left[\sum_{l=1}^{K}\omega^l(P_{lt})^{1-\gamma}\right]^{\frac{1}{1-\gamma}}$ the price of the world good, both expressed in home currency. Aggregating up, and writing C_t for the aggregate consumption policy across the distribution of agents, total domestic demand for home goods and for country l goods is given by:

$$C_{Ht} = (1-\alpha)\left(\frac{P_{Ht}}{P_t}\right)^{-\eta} C_t \tag{11}$$

$$C^l_{Wt} = \alpha\omega^l\left(\frac{P_{lt}}{P_{Wt}}\right)^{-\gamma}\left(\frac{P_{Wt}}{P_t}\right)^{-\eta} C_t \tag{12}$$

Production and prices. Firms in the home economy produce using a linear production function with productivity Θ that is country-specific, but constant over time (ie $\Theta^k_t = \Theta^k$ for each k, generating level differences across countries):

$$Y_t = \Theta N_t \tag{13}$$

They have flexible prices and there is perfect competition in the goods market. This implies that the home currency price of home goods is:

$$P_{Ht} = \frac{W_t}{\Theta} = \frac{w_t P_t}{\Theta} \tag{14}$$

where $w_t \equiv \frac{W_t}{P_t}$ denotes the real wage. Firms make zero profits. A standard derivation of the New Keynesian wage Phillips curve (e.g. Auclert et al. 2018) implies that wage inflation, $\pi_{wt} = \frac{W_t}{W_{t-1}} - 1$, is given by:

$$\pi_{wt} = \kappa_w\left(\frac{v'(N_t)N_t}{\frac{\epsilon_w}{\epsilon_w - 1}(1-\lambda)Z_t u'(C_t)} - 1\right) + \beta\pi_{wt+1} \tag{15}$$

where ϵ_w is the elasticity of substitution between unions in labor demand and λ is the progressivity of taxes (taxes are distortionary for labor supply when $\lambda > 0$). Since, from (14), $\frac{P_{Ht+1}}{P_{Ht}} = \frac{W_{t+1}}{W_t}$, producer price inflation is equal to wage inflation at all times,

$$\pi_{Ht} = \pi_{wt} \tag{16}$$

We assume that there is is frictionless trade for each individual good, so that the law of one price holds everywhere.[20]

Since the world good is identical in all countries, it acts as a natural world numeraire. To implement this numeraire in a consistent and intuitive way, we introduce an infinitesimal reference country, the "star country", whose monetary policy is set to keep the price of the numeraire world good in its currency, the "star currency", always equal to 1. We further assume that the "CPI" in the star country consists entirely of world goods. By assumption, then, $P^*_{Wt} = P^*_t = 1$. We then let $\mathcal{E}_t$ be the nominal exchange rate relative to the star currency—the number of domestic currency units per units of star currency—such that an increase in $\mathcal{E}_t$ represents a depreciation of the currency relative to the star currency. The star currency is then a useful unit of account for exchange rates, with the bilateral exchange rate between any two countries k and l given by $\mathcal{E}^k_t / \mathcal{E}^l_t$.

The law of one price implies that, in each country k, the price of good l is equal to country l's home good price once expressed in country k's currency, i.e. $P^k_{lt} = \frac{\mathcal{E}^k_t}{\mathcal{E}^l_t} P^l_{Ht}$. Since, in the star currency, $P^*_{Wt} = 1$, this implies in particular that, for the home economy (where, recall, we drop the country superscript k):

$$P_{Wt} = \mathcal{E}_t \tag{17}$$

that is, the price of world goods is equal to the exchange rate in the home currency. Finally, denoting by Q_t the real exchange rate between the home and the star currency, we have:

$$Q_t = \frac{\mathcal{E}_t}{P_t} \tag{18}$$

To first order, CPI inflation is given by $\pi_t = (1-\alpha)\,\pi_{Ht} + \alpha \pi_{Wt}$. Combining this with (16), (17), and the definition of the price index, we obtain:

$$\pi_t \;=\; \pi_{wt} + \frac{\alpha}{1-\alpha}\,(q_t - q_{t-1}) \tag{19}$$

where $q_t = \log Q_t$ is the log of the real exchange rate. Equation (19) shows how real exchange rate depreciations pass through to CPI inflation, over and above domestic inflation.

[20] It would be interesting to extend this setting to allow for imperfect pass-through, such as in a local or dollar currency pricing paradigm (Devereux and Engel 2003, Gopinath, Boz, Casas, Díez, Gourinchas and Plagborg-Møller 2020, Gopinath and Itskhoki 2021).

Government. Fiscal policy sets exogenous paths for government debt B_t and spending G_t, which it spends entirely on local goods. It then levies taxes T_t by changing the slope ν_t of the retention function, with fixed progressivity λ, as in Auclert et al. (2018). Bonds are denominated in units of the domestic consumption bundle, and government spending and tax revenue are denominated in units of home goods. Bonds are short-term, and promise to pay at t the ex-ante real interest rate r_{t-1} that prevails between time $t-1$ and time t. The government budget constraint is then:

$$B_t = (1 + r_{t-1})\, B_{t-1} + \frac{P_{Ht}}{P_t}\,(G_t - T_t) \tag{20}$$

The government taxes labor income $w_t N_t$ and lets individuals retain Z_t in the aggregate, so that $\frac{P_{Ht}}{P_t} T_t = w_t N_t - Z_t$. Combining (13) and (14), aggregate pre-tax wage income is:

$$w_t N_t = \frac{P_{Ht}}{P_t} \Theta N_t = \frac{P_{Ht}}{P_t} Y_t \tag{21}$$

We therefore have the following relationship between post-tax income Z_t, output Y_t, and taxes T_t:

$$Z_t = \frac{P_{Ht}}{P_t}\,(Y_t - T_t) \tag{22}$$

Monetary policy sets the ex-ante real rate for $t \geq 0$. We consider three different rules. The first is a real interest rate rule,

$$r_t = r \tag{23}$$

We think of this rule as capturing the case of "no monetary response", since it holds fixed the vehicle of monetary transmission to the real economy, which is the domestic-CPI-based real interest rate. By contrast, a Taylor rule allows for a response of the real interest rate to local economic conditions captured by the aggregate inflation rate:

$$i_t = r^* + \phi_\pi \pi_t \tag{24}$$

The third rule we consider simply implements the path of "natural" interest rates, which ensures that there is no wage inflation at any time, ie $\pi_{wt} = \pi^n_{wt} = 0$,

$$r_t = r^n_t \tag{25}$$

This path corresponds to the flexible-wage limit of the model, in which unions can flexibly set wages.[21]

[21] This limit is close, but not identical, to the model in which all agents are *individually* on their labor

In our analysis below, we will at times consider the limit of a perfectly open economy, $\alpha \to 1$, that follows the constant-r monetary policy rule (23). We spell out this limit in appendix B.4, where we show that this is identical to a monetary policy that targets a constant path for the terms of trade $\frac{P_{Ht}}{P_{Wt}}$.[22]

World demand for home goods. Appendix B.1 shows that, combining each country's demand system with the law of one price, world demand for the home good is given by:

$$C^*_{Ht} = \omega \left(\frac{P_{Ht}}{P_{Wt}}\right)^{-\gamma} C^*_t \tag{26}$$

where C^*_t is world import demand, equal to:

$$C^*_t = \sum_{l=1}^{K} \alpha^l \left(Q^l_t\right)^{-\eta} C^l_t \tag{27}$$

Asset pricing equations. The domestic mutual fund's liabilities consist of home real bonds B_t and star country bonds B^*_t. The latter pay a nominal interest rate of i^*_t in star currency. Since $P^*_{Wt} = 1$ at all times, i^*_t is also equal to the real interest rate in terms of the world goods bundle, which is common across all countries. At every point in time, the liquidation value of the mutual fund's liabilities equals the value of its assets, which implies:

$$\left(1 + r^p_t\right) A_{t-1} = \left(1 + r_{t-1}\right) B_t + \left(1 + i^*_{t-1}\right) Q_t B^*_t$$

Optimization implies that, for all $t \geq 0$, ex-ante CPI-based real interest rates across countries are related by the real uncovered interest rate parity (UIP) condition:

$$1 + r_t = \left(1 + i^*_t\right) \frac{Q_{t+1}}{Q_t} \tag{28}$$

as well as the domestic no-arbitrage condition $r^p_{t+1} = r_t$ for all $t \geq 0$. We further assume that gross foreign asset positions are zero initially, that is, $A_{ss} = B_{ss}$, implying $r^p_0 = r_{ss} = r_{-1}$.[23] We therefore have:

$$r^p_t = r_{t-1} \quad \forall t \geq 0 \tag{29}$$

supply curves at all times. The difference comes from the fact that (a) unions still have monopoly power, and (b) the relationship $\frac{v'(N_t)}{u'(C_t)} = \frac{\epsilon_w}{\epsilon_w - 1}\left(1 - \lambda\right) \frac{Z_t}{N_t}$ holds in the aggregate but not for each individual.

[22] By contrast, in this limit the real exchange rate Q_t is outside of the control of monetary policy.

[23] This would be different if the mutual fund invests in international assets/liabilities, there is an initial net foreign asset position, or government bonds are long-term. See Auclert et al. (2021c) for a model in which this is the case.

Finally, assuming that the mutual fund can also invest in zero-net-supply domestic nominal bonds, we obtain the nominal UIP equation, as well as the Fisher equation:

$$1 + i_t = (1 + i_t^*) \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \tag{30}$$

$$1 + i_t = \frac{1 + r_t}{1 + \pi_{t+1}} \tag{31}$$

Equilibrium. We define equilibrium in two steps. First, we define an open-economy equilibrium for given world "star" interest rate and export demand $\{i_t^*, C_t^*\}$. Second, we define an integrated world equilibrium, in which $\{i_t^*, C_t^*\}$ are endogenously determined. Since a small open economy is too small to affect $\{i_t^*, C_t^*\}$, it can be analyzed as a open-economy equilibrium given these two aggregates. This formulation therefore provides a natural extension of the Galí and Monacelli (2005) model to an integrated world economy in which global asset and goods markets clear.

Definition 1. Given sequences for star currency monetary policy and world exports $\{i_t^*, C_t^*\}$, as well as paths for fiscal policy $\{G_t, B_t\}$, an **open-economy equilibrium** is a sequence of aggregates $\{Q_t, Y_t, C_t, A_t, T_t, Z_t, r_t\}$ as well as mutually consistent policy functions and distributions of individuals over their state variables (a, e), such that:

a) The real interest rate parity condition (28) holds.

b) The relative prices $\frac{P_{Ht}}{P_t}$ and $\frac{P_{Ht}}{P_{Wt}}$ are consistent with the real exchange rate Q_t and the pricing equation for world goods (17).

c) Taxes T_t ensure that (20) holds and real income Z_t by (22).

d) Household choices are optimal given $\{Z_t, r_t\}$, and their aggregation is given by $\{C_t, A_t\}$.

e) Domestic wage inflation and CPI inflation satisfy (15) and (19).

f) r_t is consistent with the country's monetary policy rule, that is, one of (23), (24), or (25).

g) The domestic goods market clears:

$$Y_t = C_{Ht} + C_{Ht}^* + G_t \tag{32}$$

In an open-economy equilibrium, any excess of demand for assets domestically A_t relative to its supply B_t is held abroad in the form of a net foreign asset position, which we write as nfa_t:

$$A_t = B_t + \text{nfa}_t \tag{33}$$

The trade deficit of the economy is given by

$$TD_t \equiv C_t - \frac{P_{Ht}}{P_t}(Y_t - G_t) \tag{34}$$

Appendix B.2 shows that, in equilibrium, the trade deficit is related to the current account CA_t (the change in the net foreign asset position) via the standard balance of payments identity:

$$CA_t \equiv \text{nfa}_t - \text{nfa}_{t-1} = r_{t-1}\text{nfa}_{t-1} - TD_t \tag{35}$$

Because we ruled out initial gross positions, there are no valuation effects in (35).

We now turn to the world economy. In it, C_t^* and i_t^* are endogenously determined, as per the following definition.

Definition 2. A **world economy equilibrium** given country-specific productivity level Θ^k, preference parameters $\{\alpha^k, \omega^k, \beta^k\}$, income processes e_t^k, monetary policy rules, and fiscal policy paths $\{G_t^k, B_t^k\}$, is a set of world variables $\{i_t^*, C_t^*\}$ and country-specific aggregates $\{Q_t^k, Y_t^k, C_t^k, A_t^k, T_t^k, Z_t^k, r_t^k\}$ such that, in each country, $\{Q_t^k, Y_t^k, C_t^k, A_t^k, T_t^k, Z_t^k, r_t^k\}$ is an open-economy equilibrium given country-specific parameters and $\{i_t^*, C_t^*\}$, world export demand equals world import demand:

$$C_t^* = \sum_{k=1}^{K} \alpha^k \left(Q_t^k\right)^{-\eta} C_t^k \tag{36}$$

and the price of world goods in the star currency P_{Wt}^* is constant and equal to 1,

$$\sum_{k=1}^{K} \omega^k \left(\frac{P_{Ht}^k}{\mathcal{E}_t^k}\right)^{1-\gamma} = 1 \tag{37}$$

In appendix B.3, we show that these conditions are equivalent to world asset market clearing, which reads:

$$\sum_k \frac{A_t^k}{Q_t^k} = \sum_k \frac{B_t^k}{Q_t^k} \tag{38}$$

or alternatively, by (33), the world's net foreign asset position is zero:

$$\sum_k \frac{\text{nfa}_t^k}{Q_t^k} = 0 \tag{39}$$

In a world economy equilibrium, the world goods market also clears, which reads:

$$\sum_k \frac{P_{Ht}^k}{\mathcal{E}_t^k}\left(Y_t^k - G_t^k\right) = \sum_k \frac{P_t^k C_t^k}{\mathcal{E}_t^k} \tag{40}$$

Calibration. We next calibrate the world economy equilibrium of our model. We use this calibration to analyze the open economy equilibrium of an individual small country in section 4, and the full world equilibrium in section 5.

We start from an initial steady state with no net foreign asset position in any country, $\text{nfa}^k = 0$, and where all relative prices are 1. In particular, $Q^k = \left(\frac{P_H}{P}\right)^k = 1$. (We omit the subscript "t" when discussing steady state values.) By equation (35), the trade deficit is zero in each country k, so imports and exports are equal, that is,

$$\alpha^k C^k = \omega^k C^* \tag{41}$$

where $C^* = \sum_{k=1}^K \alpha^k C^k$.

Our benchmark calibration assumes that all countries are perfectly symmetric, except for size. (We relax this assumption in section 6.) That is, countries have identical preferences, home bias α, income processes, government spending G/Y and debt B/Y relative to their GDP, and only differ in their baseline productivity level Θ^k and weight ω^k in the world basket.

In this symmetric country calibration, export weights are also consumption and GDP weights, that is, $\omega^k = \frac{C^k}{\sum_{l=1}^K C^l} = \frac{Z^k}{\sum_{l=1}^K Z^k} = \frac{Y^k}{\sum_{l=1}^K Y^l} = \frac{\Theta^k}{\sum_{l=1}^K \Theta^l}$, and world import demand is simply $C^* = \alpha \sum_{l=1}^K C^l$. Symmetry also requires that $\nu^k / \left(\omega^k\right)^\lambda$ and $\varphi^k / \left(\omega^k\right)^{1-\sigma}$ are equalized across countries, to ensure that steady state after-tax income Z^k scales with Θ^k and labor supply N^k is independent of Θ^k.

We calibrate each of these symmetric countries as a scaled version of the United States economy. In particular, we choose the income process and the degree of tax progressivity as in Auclert et al. (2018), and allow for heterogeneity in discount factors with a spread δ. We take our calibration targets to be consistent with our U.S. targets in our world-economy quantitative exercise of section 6. Government spending is $G/Y = 14\%$ of GDP, public debt is $B/Y = 82\%$ of GDP, and openness (backed out from the ratio of imports

Parameter	r	σ	η	γ	α	ϕ	λ
Value	0	1	1	1	0.16	2	0.181
Parameter	G/Y	B/Y	nfa$/Y$	β	δ	κ_w	ϕ_π
Value	0.14	0.82	0	0.992	0.098	0.1	1.5

Table 1: Calibrated parameters for the U.S.

and exports to GDP) is $\alpha = 16\%$. We then calibrate β, δ to hit a real interest rate of $r = 0\%$ annually, as in recent experience, and a quarterly MPC of 0.25, consistent with evidence from a large literature on MPCs. The calibrated parameters are summarized in Table 1.

Small open economy limit ($\Theta^k \to 0$). In section 4, we study an individual small open economy in our model. Mathematically speaking, a small open economy corresponds to a country with small productivity relative to the rest of the world ($\Theta^k \to 0$), and a correspondingly small demand for its goods in the world consumption basket ($\omega^k \to 0$). In this limit, all domestic aggregates scale with Θ^k and are therefore small themselves.[24] In particular, C^k and A^k are too small to affect any world aggregates in equations (36)–(40). Hence, any policy change in that country does not affect C_t^* or i_t^*. This result allows us to interpret the equations for an open-economy equilibrium given $\{C_t^*, i_t^*\}$ as relevant to understand the response to fiscal policy changes in small open economies.

Intertemporal MPCs (iMPCs). An important part of our analysis is to characterize household behavior in any given country. We do so by summarizing aggregate saving and consumption choices in terms of two functions, $\mathcal{A}_t$ and $\mathcal{C}_t$. These functions map the only two endogenous aggregate sequences that matter for household decisions—interest rates $\{r_s^p\}$ and after-tax incomes $\{Z_s\}$—into aggregate assets held by households and aggregate consumption,

$$A_t = \mathcal{A}_t\left(\{r_s^p, Z_s\}\right), \qquad C_t = \mathcal{C}_t\left(\{r_s^p, Z_s\}\right) \tag{42}$$

The two functions are naturally homogeneous of degree one in $\{Z_s\}$ and satisfy the aggregate budget constraint

$$\mathcal{C}_t + \mathcal{A}_t = \left(1 + r_t^p\right)\mathcal{A}_{t-1} + Z_t \tag{43}$$

[24] Mathematically, as $\Theta^k \to 0$, $\left\{Y_t^k/\Theta^k, C_t^k/\Theta^k, A_t^k/\Theta^k, T_t^k/\Theta^k, Z_t^k\Theta^k, Q_t^k\right\}$ continues to constitute an open economy equilibrium given $\{C_t^*, i_t^*\}$.

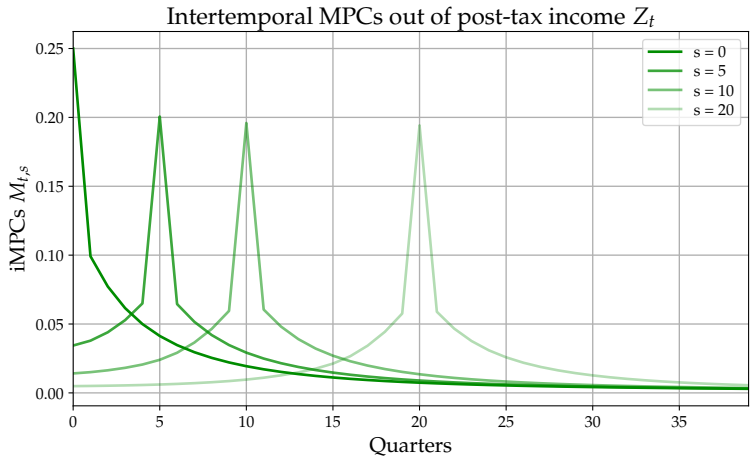


Figure 7: Intertemporal marginal propensities to consume $M_{t,s}$ (U.S. calibration)

Following Auclert et al. (2018), we define **M** as the matrix derivative (Jacobian) of the consumption sequence to the after-tax income sequence, evaluated at the steady state. That is, the entries of **M** are given by

$$M_{t,s} \equiv \frac{\partial \mathcal{C}_t}{\partial Z_s}\left(\{r, Z\}\right)$$

We call those entries *intertemporal marginal propensities to consume*, or *iMPCs*. iMPCs are a richer set of moments than standard marginal propensities to consume, in that they capture both the entire dynamic response of consumption to unanticipated income changes—the entries in the first column $(M_{\cdot,0})$ of **M**—as well as the entire dynamic response of consumption to anticipated income changes—the entries in column s, $(M_{\cdot,s})$, for an anticipated income change at date $s > 0$.

This information is critical to understanding the propagation of fiscal policy, since agents that do not immediately spend a given transfer may do so in later periods; and since agents may spend in anticipation of future transfers or income changes.

Figure 7 displays several columns s of the iMPC matrix **M** in our baseline calibration. Each line corresponds to the dynamic response of aggregate consumption to a one-time income change at date s. For example, the standard MPC is the immediate response to an unanticipated one-time unit income change and thus corresponds to the quarter-0 element of the darkest "$s = 0$" line. For future reference, we call this number $mpc \equiv M_{0,0}$; our calibration targets $mpc = 0.25$. The remaining unspent 0.75 of the unit income change is then endogenously spent in later periods. For instance, the iMPC in quarter 1 is around 0.10, and the total MPC in the first year is around 0.45. For income changes at later dates s, we see that despite some spending in anticipation of the income change, most of the

spending response happens when the income is actually received. This seems consistent with existing empirical evidence.

We next show that the iMPC matrix $\mathbf{M}$, together with the degree of openness α, are critical determinants of the propagation of fiscal policy in open economies.

4 Excess savings and twin deficits in a small open economy

In this section, we analyze fiscal policy in a small open economy ($\omega, \Theta \simeq 0$), with the world remaining at a steady state, with $i_t^* = r$ and $C_t^* = C^*$. In addition to the standard effects of fiscal policy on output, inflation and exchange rates, we pay particular attention to the model's predictions for private saving and the current account. We will argue that these predictions are unique to models such as ours that combine stable long-run asset demand and home bias, and that they line up favorably with the evidence from section 2.

Specifically, we are interested in tracing out the response of private wealth A_t and the net foreign asset position nfa_t to a change in fiscal policy, as captured in our model by changes in the exogenous time paths of government spending G_t and debt B_t. We will say that an increase in public debt ($\Delta B_t \geq 0$) causes *excess savings* when it increases private wealth ($\Delta A_t \geq 0$) and that it causes a *twin deficit* when it leads to a deterioration in the net foreign asset position ($\Delta \text{nfa}_t \leq 0$). By the asset market clearing condition (33), the equilibrium response to an increase in B must involve a combination of excess savings and twin deficits. Our goal is to study which of these two prevails, and over what horizon.

A convenient way to describe this dynamic relationship is to study flows, i.e. saving and the current account, rather than stocks. These are determined in the model by goods market clearing, and can also naturally be mapped to the data. To this end, we define private saving PS_t, the current account CA_t and the fiscal deficit FD_t, respectively, as the change in the stocks of private wealth, the net foreign asset position, and public debt:

$$PS_t \equiv A_t - A_{t-1} \qquad CA_t \equiv \text{nfa}_t - \text{nfa}_{t-1} \qquad FD_t \equiv B_t - B_{t-1}$$

It follows from asset market clearing (33) that $FD_t = PS_t - CA_t$, mirroring 5, so an increase in the fiscal deficit must be matched by an increase in private saving or a decline in the current account.

Throughout the section, we assume that the economy reverts to its natural allocation in the long run. Since, by construction, a small open economy does not affect the world interest rate, this will automatically happen under a standard Taylor rule with a constant intercept ϕ_π, provided that $\phi_\pi > 1$. This outcome also corresponds to a natural selection

under the "no monetary response" (constant-r) rule.

In addition, we focus on the case of a zero steady state net interest rate, $r = 0$, for now. This greatly simplifies the analytical expressions. Since the counterpart of this condition in a model with long-run growth is r equal to the growth rate, this is also empirically relevant, as has been widely argued (see e.g. Blanchard 2019). We relax this assumption in section 4.4.

4.1 Long-run result

Our first result concerns the long-run effects of fiscal policy. Assume that the economy is initially at a steady state, with government spending G_{ss}, debt level B_{ss}, real interest rate r_{ss} and post-tax income Z_{ss}. Suppose that fiscal policy changes, such that in the long run government spending is $G = G_{ss} + \Delta G$ and debt is $B = B_{ss} + \Delta B$. How does this affect the economy's steady state?

The key to answering this question is to consider the determinants of the long-run level of private wealth. In any steady state, (42) shows that this level is a function $A(r, Z)$ of the long-run real interest rate r and the level of post-tax income Z. Combining this observation with the steady-state market clearing condition (33), we obtain:

$$A(r, Z) = B + \text{nfa} \tag{44}$$

The left-hand side of (44) is long-run domestic asset demand, determined by the long-run real interest rate and level of post-tax income. The right-hand side is domestic asset supply, here made of bonds, plus the net foreign asset position. Building on this observation, the following proposition solves for the long-run effect of fiscal policy.

Proposition 1. *Assume that $r = 0$ and that the economy converges back to the natural allocation in the long run. Suppose that long-run government spending is unchanged $\Delta G = 0$, and that government debt increases by ΔB. Then, the long-run features an unchanged real exchange rate $\Delta Q = 0$, an unchanged level of real income $\Delta Z = 0$, as well as zero excess savings and a perfect twin deficit:*

$$\Delta A = 0 \qquad \Delta nfa = -\Delta B$$

In particular, the long-run "pass-through" of public debt into the net foreign asset position is $LRPT = -\frac{\Delta nfa}{\Delta B} = 1$.

If government spending increases by a small amount dG in addition to a small debt increase of dB, then to first order, the real exchange rate changes by $\frac{dQ}{Q} = -\frac{1-\alpha}{\chi-1}\epsilon\frac{dG}{Y}$ and excess savings and

twin deficits are given by:

$$dA = -\epsilon \cdot A \cdot dG \qquad dnfa = -\left(dB + \epsilon \cdot A \cdot dG\right)$$

where $\epsilon \equiv \left(\frac{\sigma-1}{1+\varphi} + \left(1 - \frac{G}{Y}\right)\left(1 + \frac{\alpha}{\chi-1}\right)\right)^{-1}$ *and* $\chi = \eta\left(1-\alpha\right) + \gamma$.

The key to this proposition is that, under our assumptions, a change in long-run B at constant long-run G does not change either the long-run real interest rate or the level of after-tax income ($r = r_{ss}$, $Z = Z_{ss}$). The real interest rate is unaffected because the economy is too small for its fiscal policy to affect the rest of the world, and after-tax income is unaffected because, at $r = 0$, no local tax increase is necessary to finance the increase in B. Hence, irrespective of how much fiscal policy affects private wealth in the short run, the long run level of private wealth is unchanged at $A\left(r, Z\right)$, and the increase in B is therefore entirely absorbed by foreigners.

Note that this result is true irrespective of the monetary policy that is followed along the path (assuming that it gets the economy back to the natural allocation), and irrespective of what is done with the fiscal expansion along the path (government spending or transfers, provided that government spending is back at steady state in the long run). The logic behind it is very general, and only relies on the existence of a stable long-run asset demand function $A\left(r, Z\right)$. For instance, an identical result would hold if we added capital to our model, or if the household model generated a long-run asset demand function $A(r, Z)$ for some other reason than our benchmark of precautionary savings and borrowing constraints. We come back to the question of which models fit this bill in section 4.4.4.

If government spending G changes in the long run, the real exchange rate Q, consumption C and real income Z are affected. If real income declines as a result of this increase in G, as happens under plausibly high long-run elasticities (for instance, $\sigma \geq 1$ and $\chi \geq 1$), then the long-run pass-through of public debt into the net foreign asset position $LRPT = -\frac{dnfa}{dB}$ is even greater than 1, due to the combination of reduced asset demand and increased asset supply.

4.2 Short-run dynamics without a monetary policy response

Proposition 1 shows that any increase in public debt in a small open economy with a well-defined long-run asset demand function $A(r, Z)$ is eventually entirely held abroad. However, this cannot happen right away. By the balance of payments identity (35), a deterioration in the net foreign asset position requires a sequence of trade deficits, in the

form of higher imports or lower exports. In turn, the change in imports and exports must be induced by the change in fiscal policy.

Here, we characterize analytically this transition. We stack the entire paths of government spending $\{dG_t\}$ and public debt $\{dB_t\}$ into vectors, which we denote by $d\mathbf{G} = (dG_0, dG_1, \ldots)$ and $d\mathbf{B} = (dB_0, dB_1, \ldots)$, and similarly for other variables. We then solve for the first-order impulse response of all macroeconomic aggregates to this change.

Solving for the transition requires an assumption about monetary policy. In this section, we consider the case of "no monetary response", in which monetary policy maintains a constant r throughout, i.e. (23), with $r = 0$. We also assume that any government spending change is transitory, so that $\lim_{t\to\infty} dG_t = 0$. Under these conditions, we know from proposition (1) that the long run real exchange rate $\lim_{t\to\infty} Q_t$ is unchanged and equal to $Q = 1$. Combined with the real UIP condition (28), and given $i_t^* = r = 0$, it then follows that the entire path of real exchange rates is unchanged, as well:

$$Q_t = \frac{P_{Ht}}{P_t} = 1 \quad \forall t \tag{45}$$

This result implies that any causal effect of fiscal policy on the trade balance must go through changes in import demand, rather than through expenditure switching. In section 4.4 we consider alternative monetary policy rules, in which expenditure switching also plays a role.

Since $r_t = 0$ for all t, the government budget constraint (20) implies that the fiscal deficit FD_t is also the primary deficit, i.e.:

$$FD_t = B_t - B_{t-1} = \frac{P_{Ht}}{P_t}(G_t - T_t) = G_t - T_t \tag{46}$$

Recall that our equilibrium takes as exogenous the path of government spending and the path of public debt B_t (or, equivalently, fiscal deficits FD_t). By equation (46), any increase in the fiscal deficit that is not used to finance government spending leads to lower taxes, i.e. transfers to households.

The next two propositions consider the first-order effect of exogenous changes in $d\mathbf{G}$ and the fiscal deficit $d\mathbf{FD}$. We begin with the case without home bias, and then consider the case with home bias.

4.2.1 Case with no home bias ($\alpha \to 1$)

In the limit with no home bias $\alpha \to 1$, the following proposition summarizes the effect on our outcomes of interest.

Proposition 2. *Assume constant-r monetary policy,* $r = 0$, $\lim_{t\to\infty} dG_t = 0$, *and no home bias* $\alpha \to 1$. *Then, the first-order responses of output* $d\mathbf{Y}$, *the current account* $d\mathbf{CA}$, *and the trade deficit* $d\mathbf{TD}$ *are given by:*

$$d\mathbf{Y} = d\mathbf{G} \tag{47}$$

$$-d\mathbf{CA} = d\mathbf{TD} = \mathbf{M}d\mathbf{FD} \tag{48}$$

$$d\mathbf{PS} = (I - \mathbf{M})\, d\mathbf{FD} \tag{49}$$

Equation (47) shows that the effect on domestic output only depends on local government spending, with a fiscal multiplier of 1. Equation (48) shows that fiscal deficits cause a current account and trade deficit (a "twin deficit") with a dynamic pass-through exactly equal to the iMPC matrix $\mathbf{M}$. Equation (49) shows that fiscal deficits cause a rise in private saving ("excess saving") with a pass-through given by the matrix of intertemporal marginal propensities to save, $I - \mathbf{M}$.

The logic behind these results is as follows. Consider first the case where local government spending changes without a change in the fiscal deficit, so that the government raises taxes contemporaneously. Equation (47) shows that this affects local GDP one for one with the rise in spending. This result is made possible by our monetary policy assumption: see Woodford (2011) for the representative-agent case and Auclert et al. (2018) for the heterogeneous-agent case in a closed economy setting. The additional spending causes pre-tax incomes to increase by as much as taxes do, and since these have the same incidence across the population, there is no effect on post-tax incomes for anyone, and therefore no effect on either private savings or private spending.

Next, consider the case where the fiscal deficit changes. Combining equations (22) and (46), we see that this change affects post-tax incomes by the magnitude of the fiscal deficit, $d\mathbf{Z} = d\mathbf{Y} - d\mathbf{T} = d\mathbf{G} - d\mathbf{T} = d\mathbf{FD}$. The matrix of intertemporal marginal propensities to consume then determines how much is saved and goes into private saving $(I - \mathbf{M})\, d\mathbf{FD}$, and how much of it is spent ($\mathbf{M}d\mathbf{FD}$). Importantly, because there is no home bias, all spending is on foreign goods, and therefore affects the trade and current account deficits one for one.[25]

The dark green line in figure 8 illustrates this logic in the case of a one-time, permanent shock to the debt level, as visualized in the top left panel. This is an especially instructive case to understand equilibrium adjustment, and corresponds to the typical case in which

[25]The same logic would prevail in an endowment economy with a single worldwide good, as in the canonical Blanchard (1985) model, rather than in our model with a produced good and our particular assumption about monetary policy.

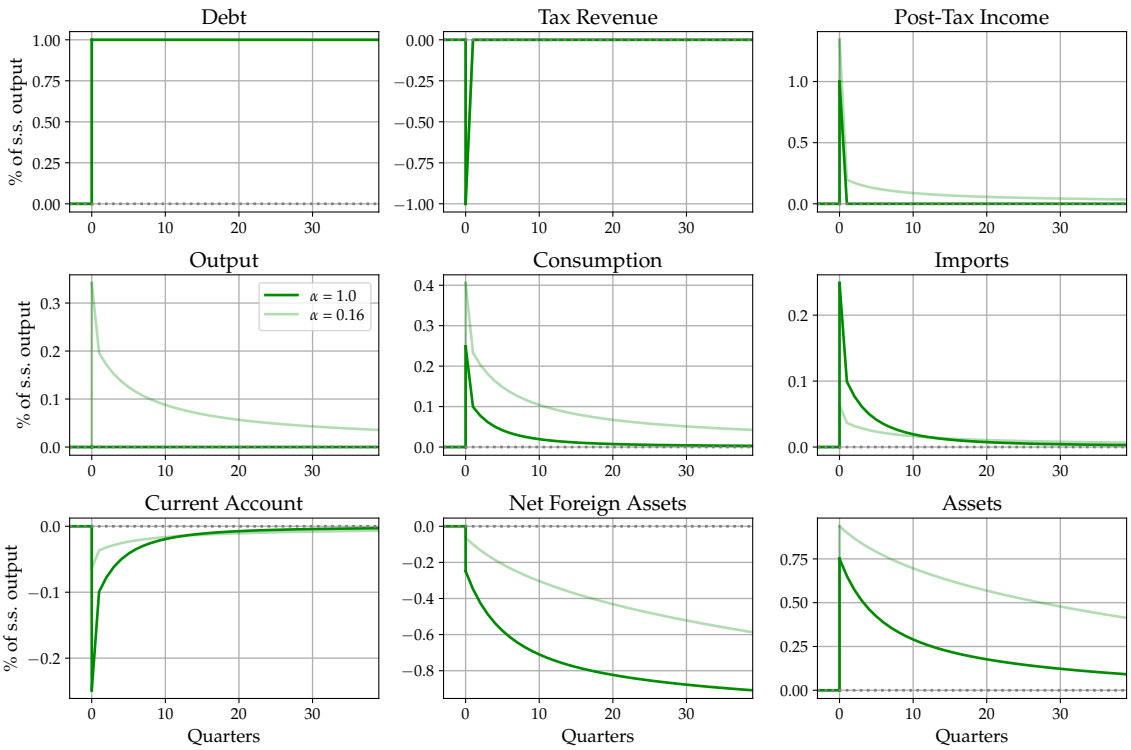


Figure 8: Impulse response to a transfer under different degrees of openness α

public debt rises because the government sends one-off transfers to households. Here, the path of current account deficits is exactly equal to that of iMPCs out of unanticipated transfers in figure 7. In particular, the impact effect on the current account deficit of a unit change in dB is equal to 0.25. The net foreign asset position follows the cumulative iMPCs $\sum_{s=0}^{t} M_{0s}$. The long-run pass-through of 1 from proposition C.1 obtains because households' intertemporal budget constraints imply that $\sum_{s=0}^{\infty} M_{0s} = 1$.

The reason why MPCs matter here is straightforward: in the aggregate, a fiscal deficit increase of \$100 leads households to receive \$100 in transfers, out of which they immediately spend $M_{0,0}$ dollars. Since there is no home bias, all of this is extra spending is on imports, leading to a current account deterioration on impact of $M_{0,0}$. Taking stock, the short-run "pass-through" of the fiscal deficit into the current account deficit when there is no home bias is:

$$SRPT^{\alpha=1} = \frac{-dCA_0}{dFD} = \frac{-d\text{nfa}_0}{dFD} = M_{0,0}$$

As households keep spending down their excess savings and the spending response builds up, imports remain elevated and the current account remains in deficit, until the point at which the country has accumulated a foreign debt equal to the increase in government debt.

This discussion illustrates the importance of iMPCs in disciplining the time path of twin deficits. There is a great deal of evidence that iMPCs are elevated not just at times when households receive the transfers, but also afterwards, as in figure 7. One general equilibrium implication is that we expect current account deficits to be more persistent than fiscal deficits.

4.2.2 General case with home bias ($\alpha < 1$)

The next proposition provides the impulse responses in the more general case with home bias $\alpha < 1$.

Proposition 3. *Assume constant-r monetary policy, $r = 0$, and $\lim_{t\to\infty} dG_t = 0$. Then, the first-order responses of output $d\mathbf{Y}$, the current account $d\mathbf{CA}$, and the trade deficit $d\mathbf{TD}$ are related to the iMPC matrix $\mathbf{M}$ and openness α via:*

$$d\mathbf{Y} = d\mathbf{G} + (1-\alpha)\,\mathbf{M}\left(\sum_{k\geq 0}(1-\alpha)^k\,\mathbf{M}^k\right)d\mathbf{FD} \tag{50}$$

$$-d\mathbf{CA} = d\mathbf{TD} = \alpha\mathbf{M}\left(\sum_{k\geq 0}(1-\alpha)^k\,\mathbf{M}^k\right)d\mathbf{FD} \tag{51}$$

$$d\mathbf{PS} = (I-\mathbf{M})\left(\sum_{k\geq 0}(1-\alpha)^k\,\mathbf{M}^k\right)d\mathbf{FD} \tag{52}$$

The proof is in appendix C.2. This result can be seen as a combination of the closed-economy analysis of fiscal policy in Auclert et al. (2018) and the open-economy analysis of exchange rates and monetary policy in Auclert et al. (2021c).

Just as in proposition 2, and for the same reason, a change in government spending has a one-for-one effect on output. However, with home bias, the response to fiscal deficits is different. Consider now a change in the time path of fiscal deficits with no change in government spending $d\mathbf{G} = 0$, so that all that changes is transfers to households $-d\mathbf{T} = d\mathbf{FD}$. Households still spend these transfers according to their MPCs. But now, a fraction $1-\alpha$ of this additional spending is used to purchase domestic goods, which boosts country income, and is therefore spent again. The resulting effect on output is that of a standard Keynesian cross, but here each round of spending affects the time path of output according to $((1-\alpha)\,\mathbf{M})^k$. This explains the right-hand sides of equations (50)–(52), which correspond to the general equilibrium change in total post-tax income induced by the change in the fiscal deficit.

Apart from these general equilibrium effects on income, the key difference to propo-

sition 2 is that, now, the response of the current account deficit is characterized by $\alpha \mathbf{M}$ rather than $\mathbf{M}$. This effect is critical to slow down the pass-through of the fiscal deficit to the current deficit. To understand this effect quantitatively, consider again a one-time, permanent shock to the debt level, as visualized in the light green line of figure 8 for our baseline US calibration to $\alpha = 0.16$.

Here also, the direct effect of a fiscal deficit of \$100 is that households receive \$100, of which they spend $M_{0,0}$ \$. However, only $\alpha \times M_{0,0}$ \$ is spent on imports. This is much smaller in practice than $M_{0,0}$. This explains why the impact effect on the current account deficit in figure 8 is much below 0.25. Because of the general equilibrium effect on output, however, this effect is higher in absolute value than $\alpha \times M_{0,0}$. One simple way to understand this adjustment process is to think about a case where households do not anticipate any future increases in income.[26] In this case, the short-run pass-through parameter would be:

$$SRPT^{na} = \frac{\alpha \cdot M_{0,0}}{1 - (1 - \alpha) M_{0,0}} \tag{53}$$

This is still much smaller than $M_{0,0}$ for any realistic calibration of mpc and α. Taking account of the dynamic effects requires using the full expression for the current account in equation (51). If we let $\mathbf{e}_0' = \begin{pmatrix} 1 & 0 & 0 & \cdots \end{pmatrix}$ be the vector with one as the first element and zeros everywhere else, the full expression for the pass-through is:

$$SRPT = -\alpha \mathbf{e}_0' \left(I - (1 - \alpha) \mathbf{M}\right)^{-1} \mathbf{M} \mathbf{e}_0 dB \tag{54}$$

while in practice this makes the $SPRT$ a little bit larger than $\alpha \times M_{0,0}$, figure 8 shows that this number is still substantially below 0.25. This implies a slow buildup of the foreign ownership of debt.

Taking stock, the combination of limited MPCs and home bias leads to slow transition dynamics in response to increases in public debt.

4.3 Who holds the new assets? The three phases of ownership

An advantage of our HANK model is that it allows us to trace out the cross-sectional patterns that underlie any fiscal expansion. Figure 9 traces out the dynamics of ownership that underlie the one-time debt-expansion experiment in figure 8. The dark purple area corresponds to the increase in wealth for the top 20% of the wealth distribution at each point in time, while the light purple area corresponds to the wealth increase for the next 80%. Together, these two sum to the "Asset" line in figure 8. Finally, the blue area corre-

[26] We explicitly spell out this "no anticipation" model in appendix C.3.

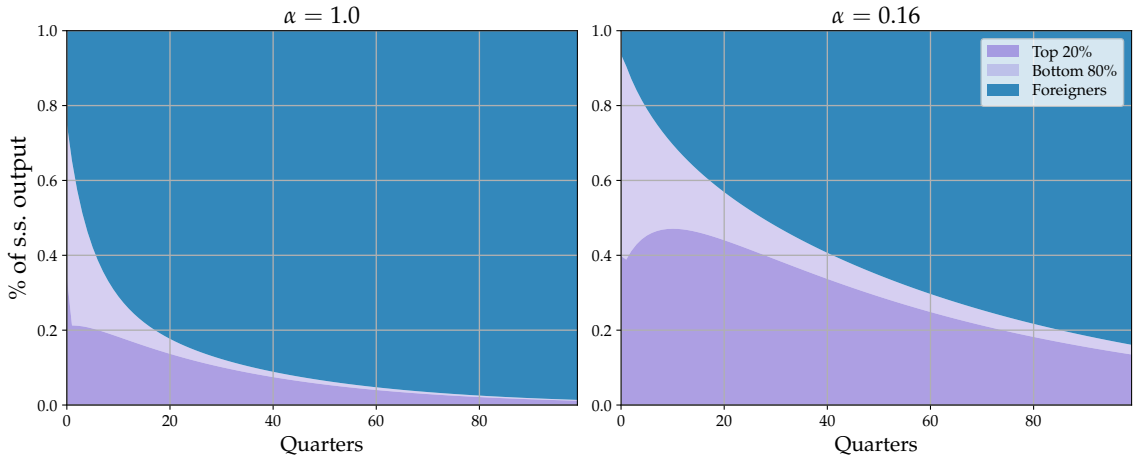


Figure 9: Three phases of asset ownership

sponds to the negative of the net foreign asset position, i.e. the amount of the marginal public debt held by foreigners.

The left panel considers the case with no home bias, $\alpha \to 1$. Initially, poor and rich both increase their savings in response to the transfers, but the poor spend down these savings much more quickly than the rich. One can summarize these dynamics in *three phases*: First, private wealth rises for all households; then, it remains elevated only for rich households; and eventually, all debt is held by foreigners.

The right panel of the figure displays the same outcomes in our calibration to the U.S degree of home bias, $\alpha = 0.16$. Here, the three phases are even more pronounced: as the poor initially spend down their transfers, economic activity rises, which allows the rich to keep increasing their savings as the poor spend theirs down. This phenomenon relies on the output boom from the spending, and is therefore not present in the left panel.[27]

4.4 Extensions

We now consider four extensions that address the main limitations of our analysis.

4.4.1 $r \neq 0$ case

Appendix C.4 revisits propositions 1–3 in the case with $r \neq 0$. The steady state result is similar, but the long-run pass-through is no longer exactly 1. With $r > 0$, the LPRT is typically above 1, as a government debt expansion leads to a reduction in post-tax income and therefore asset demand. The dynamic equations, however, are the same, provided

[27] If a monetary response—such as in the upcoming section 4.4.2—limits the output boom, we still see a similar effect, now because the rich increase their savings in response to the higher interest rate.

that, in propositions 2 and 3, we replace $-d\mathbf{CA}$ with the trade deficit $d\mathbf{TD}$, and $d\mathbf{FD}$ with the primary deficit $d\mathbf{PD}$.

4.4.2 Monetary policy response

We next consider alternative monetary policies, deviating from the constant-r rule in (23). We study a Taylor rule targeting home goods inflation (24), and the natural allocation that induces a zero domestic inflation path at all times (25). Figure 10 shows the results of simulations under these alternative monetary policy rules. Because the fiscal shock is inflationary, under these rules it induces a monetary tightening whose main effect is to reduce the output response. Import demand is consequently reduced. However, the current account dynamics (and therefore those of net foreign assets) are very similar to the constant-r case. This is because, the appreciation of the real exchange rate from the monetary tightening reduces net exports via expenditure switching.

It is possible to further understand these dynamics by considering the separate effects of the real exchange rate $d\mathbf{Q}$ and total consumption demand $d\mathbf{C}$ on the trade and current account deficit. Appendix C.2 shows that we always have:

$$-d\mathbf{CA} = \frac{-\alpha}{1-\alpha} C\left(\chi - 1\right) d\mathbf{Q} + \alpha d\mathbf{C} \tag{55}$$

where $\chi = (1-\alpha)\eta + \gamma$ is the sum of import and export elasticities. Other things equal, the appreciation deteriorates the current account provided that $\chi > 1$, an effect that can counterbalance the decline in import demand from the direct effect of monetary policy on spending. In our calibration, these two effects almost exactly offset each other.[28]

Note that the natural allocation features a twin deficit phenomenon exactly like our under our benchmark monetary rule. This shows that nominal rigidities are not important for our main results.

4.4.3 Lump-sum transfers

So far we have studied debt-financed transfer increases that occur through the regular tax schedule, and that therefore benefit the rich more in absolute terms. This allows for simple analytics, but many transfer programs (such as stimulus checks) are distributed more

[28]This result is specific to our calibration of trade elasticities to $\eta = \gamma = 1$. Under this parameterization, and in a setting with $\sigma = 1$ (i.e. the Cole-Obstfeld case) and assets that represent capitalized claims on the (constant) share of future profits, proposition 6 in Auclert et al. (2021c) shows that in general equilibrium, changes in the real interest rate $d\mathbf{r}$ have no effect on the current account (echoing a similar result in Galí and Monacelli 2005). Here, assets are bonds rather than capitalized profits, so this result does not hold exactly, but figure 10 shows that it holds approximately.

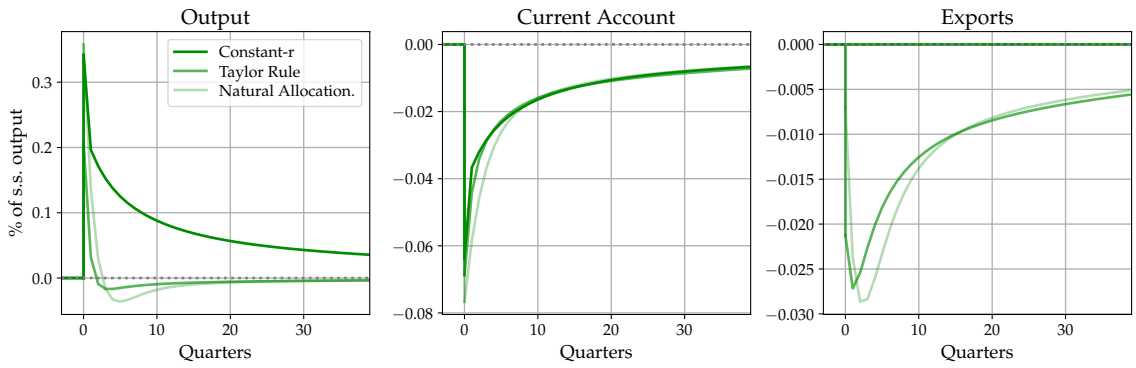


Figure 10: Impulse response to debt expansion under alternative monetary policy rules

progressively. We now study this type of case, extending proposition 3. The dynamics of output, private saving and the current account after these alternative distributions of transfers are determined by:

$$d\mathbf{Y} = (1-\alpha)\left(\sum_{k\geq 0}(1-\alpha)^k\mathbf{M}^k\right)\widetilde{\mathbf{M}}d\mathbf{FD} \tag{56}$$

$$d\mathbf{CA} = -\alpha\left(\sum_{k\geq 0}(1-\alpha)^k\mathbf{M}^k\right)\widetilde{\mathbf{M}}d\mathbf{FD} \tag{57}$$

$$d\mathbf{PS} = \left(\sum_{k\geq 0}(1-\alpha)^k\mathbf{M}^k\right)\left(I-\widetilde{\mathbf{M}}\right)d\mathbf{FD} \tag{58}$$

where $\widetilde{M}_{t,s} = \frac{\partial C_t}{\partial Tr_s}$ is now the consumption response to transfers Tr_s, which can have a different incidence than after-tax income. For instance, in the case of lump-sum transfers, $\widetilde{\mathbf{M}}$ corresponds to an equal-weighted rather than income-weighted average MPC. These equations show that the MPCs that matter for the effect of the policy, $\widetilde{\mathbf{M}}\boldsymbol{e}_0$, are different from those that matter in aggregate for the dynamic propagation of shocks, which are still given by $\mathbf{M}$.

Figure 11 shows that, compared to proportional transfers, lump-sum transfers have a larger output effect since they benefit higher MPC households on average. However, the current account and savings dynamics are very similar. In other words, while the exact distribution of transfers is critical to understanding which agent is affected, and how much of an immediate effect on output we obtain (with better-targeted transfers boosting output by more), the aggregate dynamics of domestic and foreign wealth accumulation conditional on a given path of government debt are governed by the same general forces, irrespective of how the transfers are distributed.

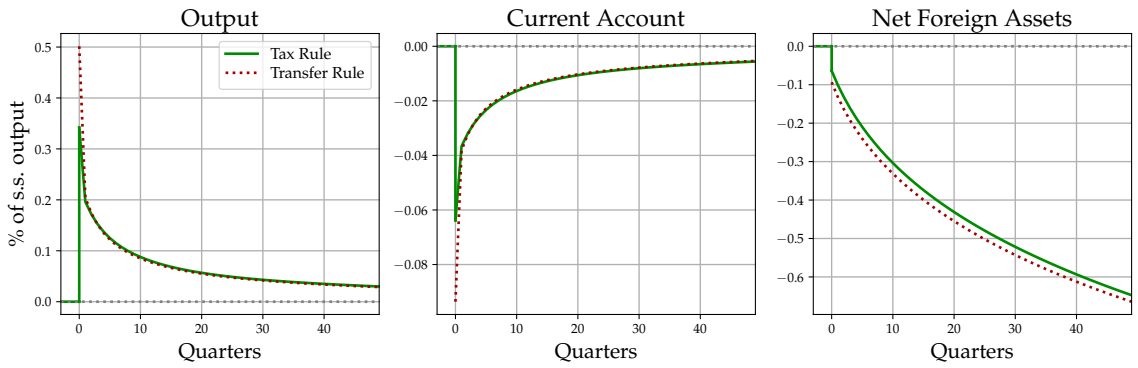


Figure 11: Impulse response to a transfer under alternative transfer distribution rules

4.4.4 Alternative models: RANK, TANK and Blanchard (1985)

Having discussed the time paths of asset ownership in our baseline model, we now consider the implications of alternative widely-used models, beginning with a representative-agent model. There, Ricardian equivalence implies that any increase in debt immediately results in excess savings, as illustrated in the left panel of figure 12. A_t tracks B_t perfectly.[29]

A more involved question is whether alternative non-Ricardian models also deliver a similar response. We consider two of the main leading non-Ricardian models in the literature, which act as tractable alternatives to heterogeneous agent models: a TANK model as in Galí et al. (2007) and Bilbiie (2008); and a perpetual youth model along the lines of Blanchard (1985).

In appendix C.5, we study the TANK model, which is made up of a fraction μ of hand-to-mouth agents and a fraction $1-\mu$ of standard infinitely-lived unconstrained consumers. We show that, in this model, the twin deficits equation (51) reduces to:

$$-d\mathbf{CA} = \frac{\mu\alpha}{1-\mu\left(1-\alpha\right)}d\mathbf{FD}$$

Here, the "no anticipation" logic that governed equation (53) applies not only to the impact effect, but at every point in time. Therefore, the TANK model provides backing for "rules of thumb", mentioned in the introduction, that translate fiscal deficits into current account deficits at the same point in time. However, the quantitative magnitudes from this particular microfounded model are difficult to reconcile with the rules of thumb in the literature. For realistic calibration, even if $\mu = 0.25$, at our U.S. calibrated value for

[29] Observe that $r = 0$ is strictly speaking not possible to achieve in a representative agent model, but $A_t = B_t$ holds irrespective of the steady state interest rate assumed in a representative agent model.

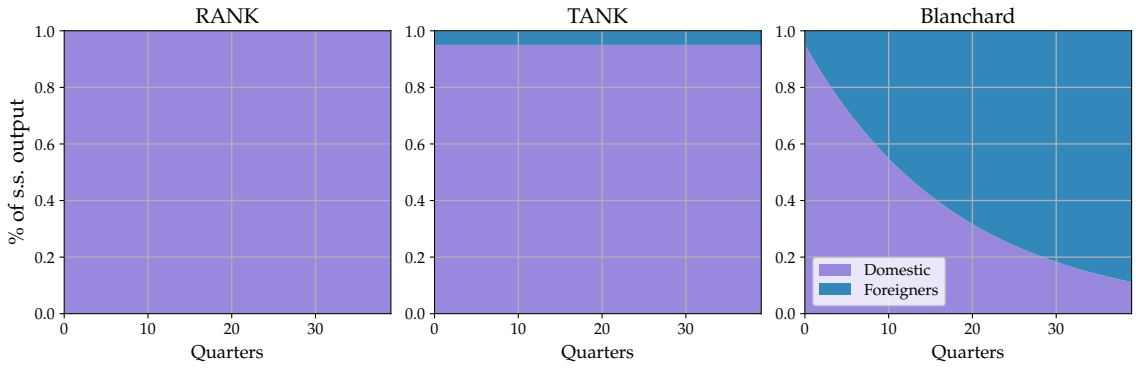


Figure 12: Impulse response to a transfer: RANK, TANK, Blanchard

openness of $\alpha = 0.157$, we find a pass-through of only about 5%, much smaller than the 30%-50% range often assumed. In the limit with $\mu = 0$, this becomes the representative-agent model with Ricardian equivalence and no impact of the fiscal deficit on the current account deficit.

Note further that the TANK model has very different dynamic behavior from our HANK model. Here, the current account deficit only lasts for as long as the transfers last (when hand-to-mouth agents spend it), so the long-run pass-through is also $\frac{\mu\alpha}{1-\mu(1-\alpha)} \ll 1$. This is illustrated in the middle panel of figure 12.

A model that behaves much closer to the HANK model is the well-known Blanchard (1985) model, which was first introduced to study analytically the effects of debt on the current account, albeit in a one-good setting. In appendix C.6, we write down the discrete time counterpart of this model. We show that it features a consumption and asset function as in (42), whose $\mathbf{M}$ matrix can be characterized in closed form, as well as a closed form long-run asset demand function $A(r, Z)$. The model's parameters can be calibrated to hit $M_{0,0}$ directly. The model also features a LPRT of 1, and its main difference in dynamics are due to the fact that it has a different $\mathbf{M}$ even when calibrating to the same $M_{0,0}$. Figure 12 illustrates how similar the Blanchard model is to the baseline HANK model once matched to the same mpc and α. Here, the decay in net foreign assets is faster than in the HANK model, because $M_{0,1}$ is larger in the Blanchard model.[30]

[30]This is due to the lack of selection into spending: unlike in TANK and HANK, where households that choose not to spend have lower propensities to spend in the future, the MPC out of excess savings is constant in the Blanchard model. We could improve the Blanchard model's fit to the $\mathbf{M}$ matrix by adding hand-to-mouth agents, since as appendix C.7 shows it is locally isomorphic to a bond-in-utility model, and Auclert et al. (2018) show that a mixture of bond-in-the utility and hand-to-mouth agents (a "TABU" model) closely approximates the $\mathbf{M}$ matrix of a HANK model

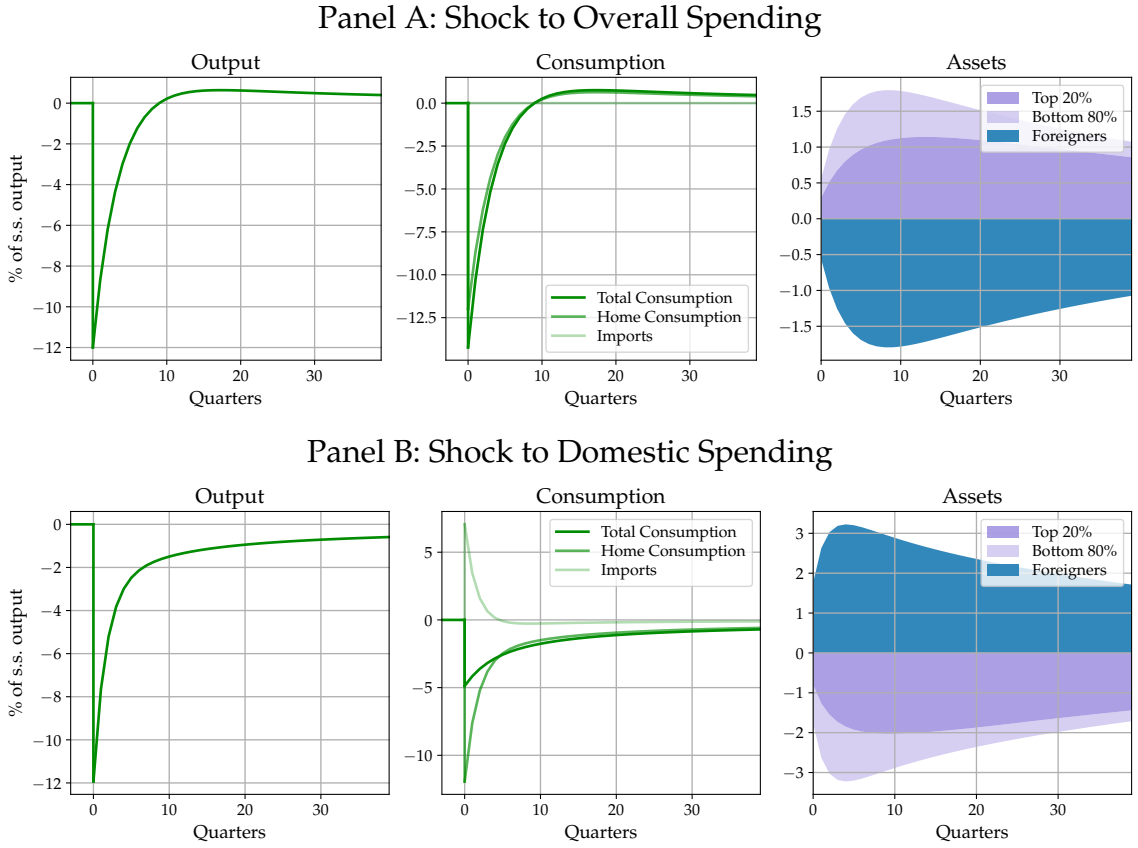


Figure 13: Covid shocks

4.5 Can a Covid shock explain excess savings and the current account?

We have seen that a fiscal deficit shock does a good job at qualitatively matching Facts 1 and 2: it is accompanied by a large increase in private savings with realistic distributional dynamics, and by a limited decline in the current account deficit that happens in slow motion.

While TD Bank 2021 and European Central Bank 2021 have argued that fiscal policy was partly responsible for the increase in observed savings (Fact 1), they conjectured that, by depressing consumption, pandemic restrictions were also very important. Here, we show that this argument misses an important part of general equilibrium: Covid restrictions depress consumption also depress income, so that the effect of these restrictions on aggregate excess saving were likely small.

We demonstrate this logic in our model using two different types of shocks to proxy for the idea that the Covid shock depressed spending.

We first consider a shock to overall spending, in the form of a shock to the discount factor β of all households in the small open economy. This shock depresses desired spend-

ing and therefore equilibrium spending, with households cutting back on both domestic and foreign spending alike. We solve for the response of the model under the constant-r monetary policy scenario, under our baseline calibration of $\alpha = 0.16$.

We calibrate this shock such that it implies a realistic decline in the level of output. In the United States, in 2020Q2, the level of output was 9% below where it had been in 2020Q1, and it had essentially entirely recovered by 2021Q2. Of course, some of this recovery was the sustained effect of the US fiscal stimulus. Using our quantitative model from section 6, we infer that fiscal policy sustained the level of output by about 3% for about two years. This implies that the pure effect of the Covid shock, absent fiscal policy, would have been to lower output by 12% in 2020Q2 and 3% in 2021Q2. We fit the standard deviation and persistence of an AR(1) shock to β to match these numbers. The resulting effect is displayed in Panel A of figure 13.

We do find that a shock to overall spending can lead to aggregate excess savings. The shock implies a decline in both home and foreign spending. The decline in home spending lowers GDP and domestic income, with no net effect on saving. The decline in foreign spending, however, leads to a current account surplus. In the aggregate, absent a rise in fiscal deficits or investment, a current account surplus is the only way in which the country can build up excess savings. Note, however, from the right panel, that the magnitude of this effect is very small: a 12% decline in GDP only leads to a peak increase of cumulative excess savings of about 1.5%, which is small compared to the observed increase of about 11% in figure 5.

A widely-noted aspect of the pandemic is that it has unequally hit sectors, with services being much harder-hit, such that the pandemic created a reallocation of activity towards goods and away from services (e.g. Baqaee and Farhi 2020, Guerrieri, Lorenzoni, Straub and Werning 2020) This suggests that an overall shock to desired spending is not the most appropriate way of modeling the Covid shock. We therefore modify equation (7) to feature a shock ζ_t to home spending

$$c_{it} = \left[(1-\alpha)^{\frac{1}{\eta}} \left(\zeta_t c_{iHt}\right)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(c_{iWt}\right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$

and solve for the general equilibrium effect of this shock.[31] We recalibrate the model to feature a low intratemporal elasticity relative to the intertemporal elasticity ($\eta = 0.5 < 1 = \sigma^{-1}$) such that the shock has a general equilibrium effect on home output (see Guerrieri et al. 2020 for a similar condition). We calibrate an AR(1) ζ_t shock to match the same

[31] Details are provided in appendix C.8.

output decline as described previously.

Panel B of figure 13 displays the effect of this shock. As expected, the shock leads to a decline in home spending and a reallocation of spending towards imports. Hence, now in equilibrium the current account and excess savings actually decline in equilibrium, with "excess dissavings" of about 3% of GDP at the peak.

Overall, this shows that the Covid shock itself may have limited general equilibrium effects on saving, because it reduces income along with consumption. Whether income or consumption declines more depends on the exact details of the shock, but the magnitude of the rise in saving falls well short of the data even in the (somewhat unrealistic) scenario that gives the most chance to this idea.

5 World economy with symmetric countries

So far we have discussed a small open economy changing fiscal policy in isolation. This is fine for small economies such as Malta in our sample, but the Covid fiscal expansion that motivates this paper was characterized by a worldwide expansion of public debt. This is clearly relevant for thinking about implications for long-run net foreign asset positions. For instance, while one country can borrow from the rest of the world, collectively the world cannot. After an increase in world debt, some mechanism must convince agents collectively to buy the new debt. In our model, that mechanism is a rising world interest rate.

Throughout this section, we maintain our benchmark symmetric-country calibration, with export weights ω^k equal to GDP weights. We derive analytical results that help interpret all of our small economy results so far as deviations from the "world average", and characterize the evolution of that world average.

5.1 Long-run result

We assume that each country conducts a small fiscal expansion of dB^k. In the interest of space, we focus on the case where we initially have $r = 0$, and countries do not increase long-run government spending, $dG^k = 0$. We then have the following proposition.

Proposition 4. *Assume that $r = 0$; that $dG^k = 0$; that the government of country k with GDP weight ω^k expands its debt by dB^k; and that all economies go back to the natural allocation in the long-run. Then, to first order, in each country the long-run real exchange rate is unchanged ($dQ^k = 0$), real income changes by the same proportion everywhere, $d \log Z^k = d \log Z$, and*

letting $B = \sum_k B^k$*, we have the same amount of excess savings everywhere and a twin deficit in higher-debt countries:*

$$d \log A^k = d \log B \qquad dnfa^k = -\left(dB^k - \omega^k dB\right) \tag{59}$$

In particular, the long-run passthrough of public debt to the NFA is $LPRT = 1 - \omega^k$*. Letting* $a(r) \equiv A(r, Z)/Z$ *denote normalized asset demand, the increase in the world interest rate that sustains this equilibrium is:*

$$dr^n = \frac{d \log B}{\frac{d \log a(r)}{dr} - a(r)\left(\frac{1}{1+\varphi}\right)\left(\frac{1}{1-\frac{G}{Y}}\right)} \tag{60}$$

Proposition 4 shows that we can think of the effect of the world fiscal expansion as having two effects. First, an average effect, which is to raise assets held worldwide, sustained by an increase in world interest rates. Second, an effect in differences from that world average, which is given by proposition 1. The long-run twin deficit result manifests itself because any increase of a country's debt over and above its share of the world's leads to a deterioration in the NFA.

The immediate implication of equation (59) is that, in any worldwide fiscal expansion, a reasonable prediction each country's long-run net foreign asset position is the difference between its debt expansion and the average debt expansion. For the Covid fiscal expansion that we are considering, these predictions are given by the bars in figure 14—the mirror image of figure 3. For instance, because it had a very limited increase in public debt, Denmark's net foreign asset position increases by around 10%, while the U.S. NFA deteriorates by around 2%. Note that, for most large countries, these long-run NFAs are relatively modest, because the fiscal expansions tended to be large everywhere.

However, the critical new aspect of a world fiscal expansion is that the world real interest rate must increase to convince households everywhere to hold the new issuances of government debt. The intuition is that the world asset market must clear (equation (38)), so desired private asset accumulation must rise enough in the long-run to offset the increase in government debt. In our model, the resulting effect on the world interest rate is given by (60).

The first column of table 2 reports numbers for our baseline calibration, applied to the fiscal expansion that we are studying. The average cumulative deficit (dB) is 12% of GDP, which is a proportional change of $d \log B = 14\%$ given an initial level of 82%. The interest semi-elasticity of asset demand in the model is around 21, implying an effect on interest

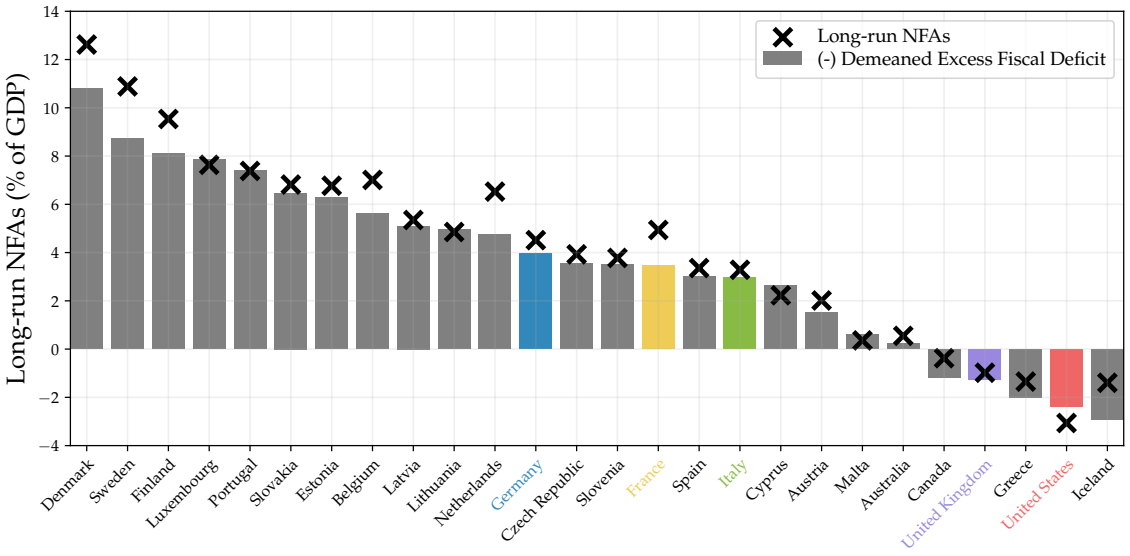


Figure 14: Long-run NFAs in quantitative model vs. predictions from proposition 4

Note: Crosses indicate the long-run NFAs in our quantitative model of section 6. Bars indicate predictions from Proposition 4 (long-run nfas in the symmetric country calibration).

rates of 67 basis points, close to the nonlinear effect in the model.

There is reason to believe that this effect on the world interest rate may be a little high. First, while the semi-elasticity of asset demand is similar to the one calculated by Auclert, Malmberg, Martenet and Rognlie (2021b) using a realistic life-cycle model, our model underestimates total assets since it ignores other components of wealth beyond public debt: hence, in practice, an increase of world public debt of 12% as a share of GDP represents a much smaller proportional increase in assets. Second, the literature review in Mian, Straub and Sufi (2022) suggests that a 10% increase in public debt raises the world interest rate only by around 20bp.

		Symmetric countries	Quantitative model
Increase in debt (% of initial)	$d \log B$	14.0%	14.0%
Interest semi-elasticity of savings	$\frac{d \log a}{dr}$	21.3	21.3
Tax adjustment	$a\,(r)\ \frac{1}{1+\varphi}\frac{1}{1-G/Y}$	0.4	0.4
First-order approximation	dr^n	67bp	67bp
Actual change	$r - r^n$	64bp	60bp

Note: This table implements equation (60) and compares the effect to solution in the full quantitative model of section 6 with asymmetric countries. Semi-elasticities and interest rate effects are reported in annualized terms.

Table 2: Effect on the long-run world interest rate from the world fiscal shock

5.2 Transitional dynamics

We now assume that countries announce an entire fiscal expansion path $\{dB_t^k\}$, eventually settling at $dB^k = \lim_{t\to\infty} dB_t^k$. Consider the transition to this new steady state. Here, again, provided that monetary policy follows the same path everywhere, we can interpret the transitions as those of a small open economy relative to the world average.[32]

Proposition 5. *If monetary policy has the same r_t response everywhere, then there is purchasing power parity for all countries at all times, $Q_t = 1$. Then, if tildes denote allocation subtracting the country's share of the world total, $\tilde{C}_t^k = C_t^k - \omega^k C_t$, with $C_t = \sum C_t^k$, all tilde allocations are given by the model of section 3 in response to demeaned impulses $d\tilde{\boldsymbol{G}}^k$ and $d\tilde{\boldsymbol{B}}^k$.*

In turn, the aggregate allocation $C_t = \sum C_t^k$ can be obtained as follows:

Proposition 6. *If monetary policy has the same r_t response everywhere, the mean allocation is characterized by the intertemporal Keynesian cross from a closed economy,*

$$\begin{aligned} d\boldsymbol{C} &= CM^r d\boldsymbol{r} + M \cdot (d\boldsymbol{Y} - d\boldsymbol{T}) \\ d\boldsymbol{Y} &= d\boldsymbol{C} + d\boldsymbol{G} \end{aligned}$$

where $d\mathbf{r}$ is the common monetary policy path.

These equations are those of the closed-economy model from Auclert et al. (2018), after allowing for a possible monetary policy response.

Together, propositions 5 and 6 provide us with a useful way of interpreting the effect of fiscal policy on the world economy. First, one can study the effect of the aggregate tax and government spending changes as if this was a closed economy with its own monetary policy response (proposition 6). This gives the worldwide allocation. (Intuitively, the world is a closed economy; note, for instance, that home bias is irrelevant for this response.) Second, one can study differences from the world average by studying the response of a small open economy assuming a constant-r response (i.e., the equations from proposition 3) given the difference in tax and spending policy from the world average (proposition 5).

[32] A similar version of these equations results can be derived for the case of a currency union, with a common nominal interest rate in every country. This result can be helpful to interpret the difference between cross-sectional and average fiscal multipliers that is the object of a vast literature.

6 Counterfactual analysis of Covid fiscal expansion

We now move on to a counterfactual analysis of the worldwide fiscal expansion. We calibrate a 26-country version of our model to observed characteristics these countries, and consider its response to a debt expansion of the magnitude observed in each country, assuming that debt will remain permanently high from now onward. We show that this model can rationalize the cross-country patterns of excess savings and current account deficits that we have documented in section 2, without resorting to any Covid shock. We then use the model to evaluate the counterfactual effect of worldwide fiscal policy on macroeconomic outcomes over the period, and use it to forecast the next decades.

6.1 Calibration and solution with non-symmetric countries

We calibrate each economy in order to hit its own degree of openness α^k, government debt B^k/Y^k, and spending G^k/Y^k. Appendix D.3 provides details of these calibration targets.

We assume that monetary policy in each country follows a Taylor rule,

$$i_t = r_t^* + \phi_\pi \pi_t$$

where r_t^* phases in the transition between the initial natural rate of interest and the long-run natural rate analyzed in table 2. Our assumption here is that monetary authorities are recognizing the pressure of fiscal policy on interest rates and acting accordingly to avoid long-run inflationary pressure.

Note that while propositions 5 and 6 provide us with an implementable way to solve for the world open economy allocation in a symmetric country calibration, here the countries are no longer symmetric, so we must solve for the 26-country allocation simultaneously. We use a novel approach, adapting the ideas of Auclert et al. (2021a), which we discuss further in appendix D.4.

6.2 Model validation for initial stage of Covid

We validate our model using the cross-country relationship between fiscal expansions, excess savings, and current account deficits documented in section 2.

We compare model and data as follows: from section 2, we compute at each quarter $t = 2020Q2,...,2021Q2$, the regression coefficient of excess savings up to that point on the cumulative fiscal deficit up to that point. Intuitively, this gives us the cumulative passthrough until then. The final passthrough is that calculated in figure 6 using the

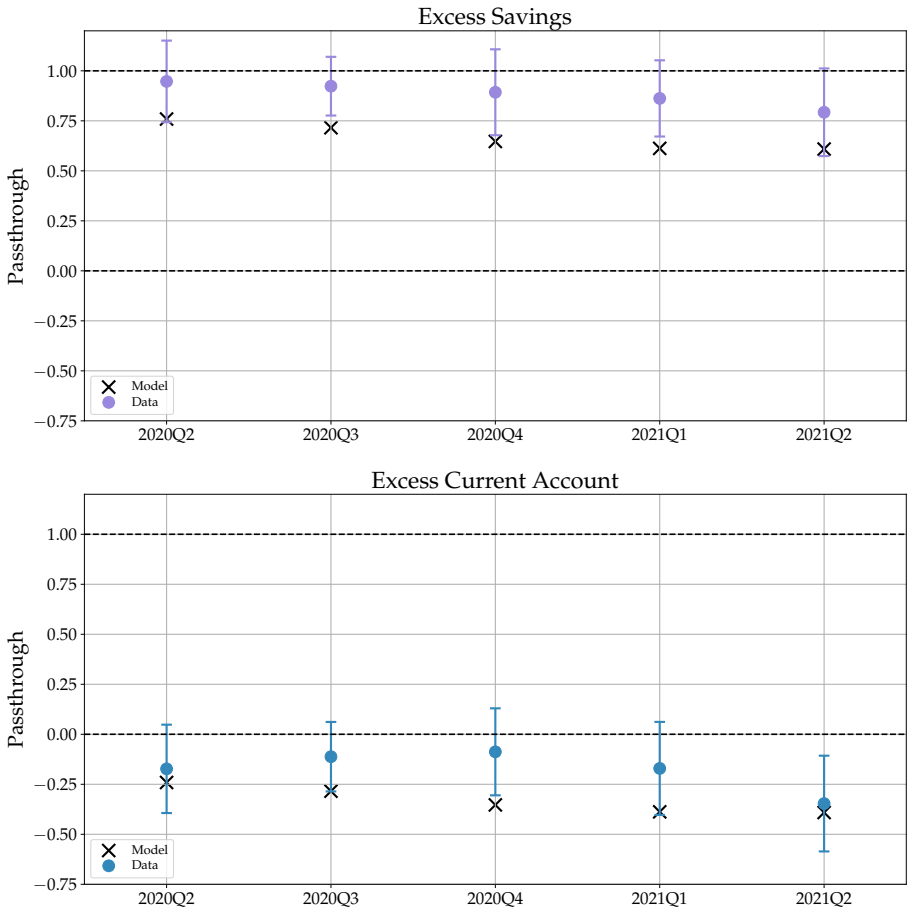


Figure 15: Dynamic passthrough coefficients in the model and the data

Note: Data corresponds to the cross-country regression at each horizon, controlling for covid deaths and lockdowns, with 68% confidence intervals. Model corresponds to the regression coefficient in the model.

latest data. The result of this exercise is given in the colored lines of figure 15. We then run the exact same regression in our data, which we report with crosses.

Figure 15 shows that the model accurately captures the large passthrough of the fiscal deficit to excess savings in the cross-section of country, as well as the fact that it declines over time. This is the quantitative manifestation of the slow transition dynamics of excess savings. Similarly, the model captures the negative and declining effect of fiscal deficits on the current account—the slow-motion, cross-country twin deficit.

6.3 Counterfactual analysis of the fiscal expansion

Armed with a model that provides a good fit to our outcomes of interest, we now use the model to predict other outcomes, in particular the levels.

We begin with the long run. The crosses in figure 14 show the predicted long-run

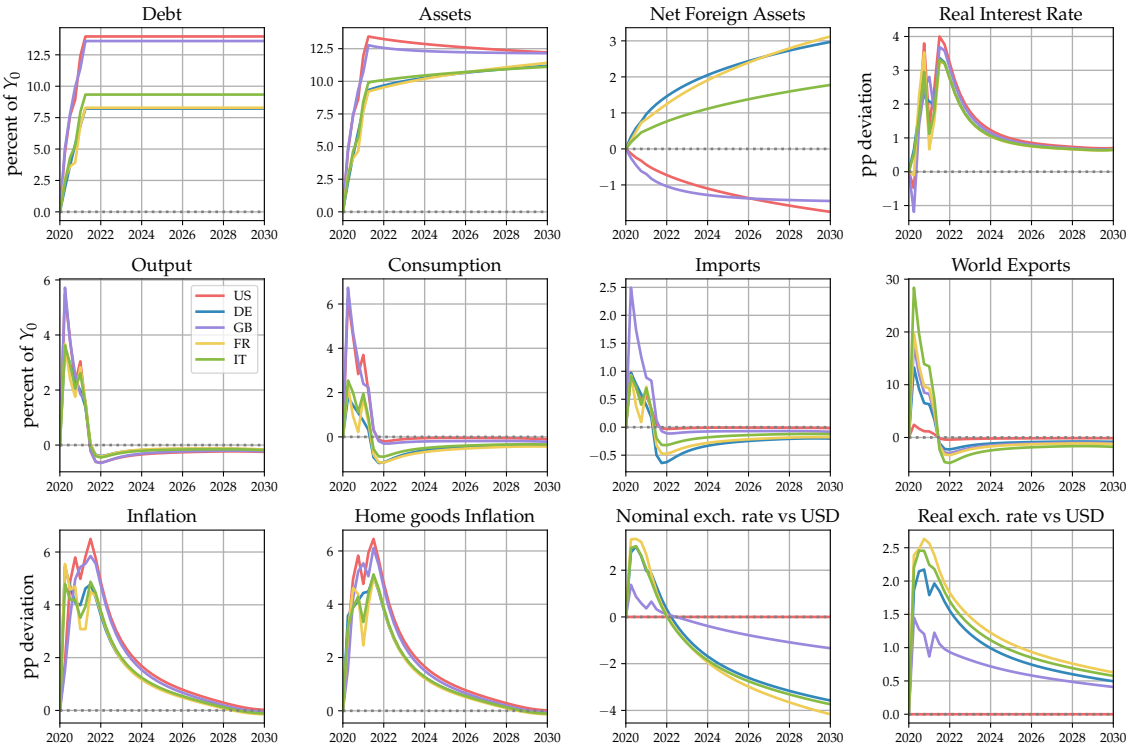


Figure 16: World economy fiscal policy counterfactual (top 5 countries)

net foreign asset positions from the quantitative world economy model of this section. They align well with our theoretical results in the symmetric world model of proposition 4 (showed in the bars).

Next, figure 16 shows the full transition dynamics of the model for the top 5 countries by GDP. It is clearly visible that the two countries with the strongest fiscal stimulus, the U.S. and the U.K., see the strongest output response on the one hand, but also the strongest increases in imports and inflation. That said, the evolution of inflation is significantly more similar across countries than the evolution of debt levels, a testament to inflation being spread across countries by global trade. Notably, the transition back down to the previous stable inflation rate is slow in the model, coming within 1pp. of the target rate only in 2025.

Finally, we use our model to recover the distribution, similar to figures 2 and 5. Figure 17 shows this for the United States and the Rest of the World separately. We see that all countries converge to the same level of excess savings in the long-run, with these savings predominantly held by the world's rich. We also see the role of twin deficits in pooling those excess savings across countries, with the transition taking a decade or more.

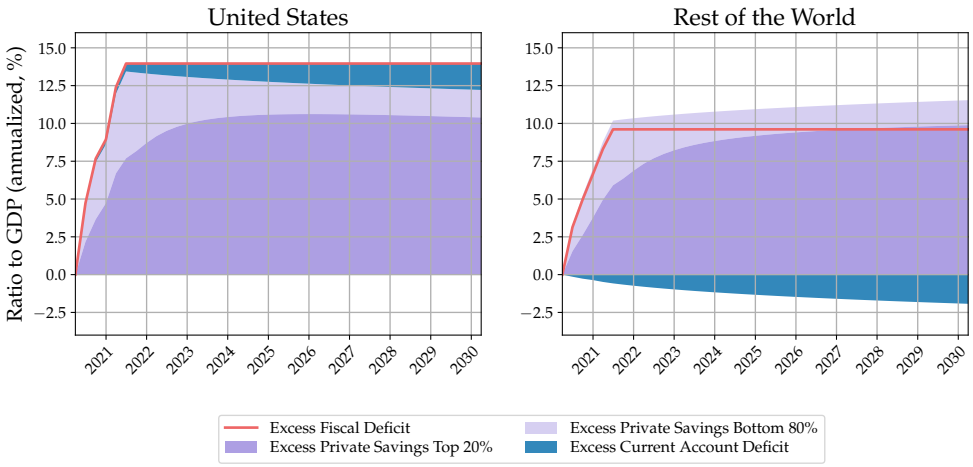


Figure 17: Excess savings and their distribution: U.S vs the rest of the world

7 Conclusion

We show that a multi-country HANK open-economy model is consistent with the initial phases of excess savings and twin deficits that followed the Covid epidemic worldwide. We find that excess savings are here to last, but that they will be held increasingly by the world's rich, and that twin deficits will continue to pool them across countries. Our model predicts that they will keep boosting output and inflation for a while, but—owing to the low MPCs of the rich—this effect will be weaker than it has been in the past.

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A Appendix to section 2

A.1 Data sources and country list

Table 3 lists the 26 economies in our study, which are the advanced economies that have non-missing data on fiscal deficits (general government net lending and borrowing) and current accounts between 2020Q1 and 2021Q2. The table also indicates, under column "R?", if countries are part of our "reduced sample" that also includes private savings and investment data over this period.

The data used in section 2 is collected as follows. General Government net lending and borrowing are from the IMF International Financial Statistics (IFS). Current account data is from the IMF Balance of Payments and International Investment Position Statistics.[33] Private savings are from the OECD Quarterly Non-Financial Sector Accounts, and are computed as gross savings net of consumption of fixed capital for the private sector.[34] Net investment data is from the OECD Quarterly National Accounts, computed as gross fixed capital formation net of the consumption of fixed capital. For the U.S., all data is taken from National Income and Product Accounts. We use seasonally adjusted data when available, otherwise use non-seasonally adjusted data. To construct Figure 1 we also construct the trade balance by subtracting imports from exports in the IMF IFS.

The data used to construct the remaining columns of Table 3 is constructed as follows. Nominal GDP is from the IMF IFS database; we report nominal GDP weights based on 2020Q1 values as share of total nominal GDP for our 26 countries.

Openness averages the import-to-GDP and export-to-GDP ratio from the World Development Indicators (WDI) over 2015–2019; government spending to GDP is the WDI average over the same period. We use the net debt-to-GDP from the IMF Fiscal Monitor averaged over 2015-2019; for Greece this number is missing and we calculate it by taking general government gross debt from the World Bank Quarterly Public Sector Debt database, and subtracting financial assets from the IFS.

A.2 With controls

Figure 18 repeats the exercise from Figure 6, but adds controls by residualizing each x-axis variable with the other two variables. For instance, the fiscal deficit is residualized

[33] We take US dollar values for the current account and convert them to domestic currency using period average exchange rates from the IMF IFS.

[34] The private sector consists of households, nonprofits serving households, financial corporations, and non-financial corporations.

Country	R?	Code	GDP weight Y^k	Openness $\frac{X^k+I^k}{2Y^k}$	Spending G^k/Y^k	Debt B^k/Y^k
United States	Y	US	52.35	13.5	14.1	81.9
Germany	Y	DE	9.32	43.4	19.9	46.3
United Kingdom	Y	GB	7.01	30.1	18.8	76.8
France	Y	FR	6.27	31.4	23.5	88.6
Italy	Y	IT	4.55	29.1	18.9	121.8
Canada	Y	CA	4.12	32.9	20.8	26.4
Australia	Y	AU	3.24	21.4	19.0	24.1
Spain	Y	ES	3.19	32.9	18.9	84.4
Netherlands	Y	NL	2.19	77.7	24.6	46.8
Sweden	Y	SE	1.29	43.2	26.0	7.2
Belgium	N	BE	1.27	80.7	23.2	88.6
Austria	Y	AT	1.05	52.4	19.5	53.9
Denmark	Y	DK	0.85	52.5	24.6	15.0
Finland	Y	FI	0.65	37.5	23.4	22.6
Czech Republic	Y	CZ	0.61	74.6	19.1	22.5
Portugal	Y	PT	0.56	41.7	17.3	115.9
Greece	Y	GR	0.49	36.3	20.3	150.3
Slovakia	N	SK	0.25	92.9	18.9	45.5
Luxembourg	N	LU	0.17	179.4	16.4	-11.2
Lithuania	N	LT	0.13	71.6	16.8	31.9
Slovenia	Y	SI	0.13	77.1	18.6	48.6
Latvia	N	LV	0.08	60.9	18.5	30.1
Estonia	N	EE	0.07	73.9	19.5	-1.9
Cyprus	N	CY	0.06	72.5	15.4	71.5
Iceland	N	IS	0.05	44.5	23.7	62.1
Malta	N	MT	0.04	141.3	16.2	37.5

Table 3: Countries in our sample and their characteristics

with the lockdown index and covid deaths, and so on. The patterns from Figure 6 are almost identical.

A.3 Accounting for fiscal deficits in the Rest of the World

Figure 19 repeats the exercise from 5 for the 16 countries that make up the Rest of the World in our reduced sample, for which all balance of payment data is available.

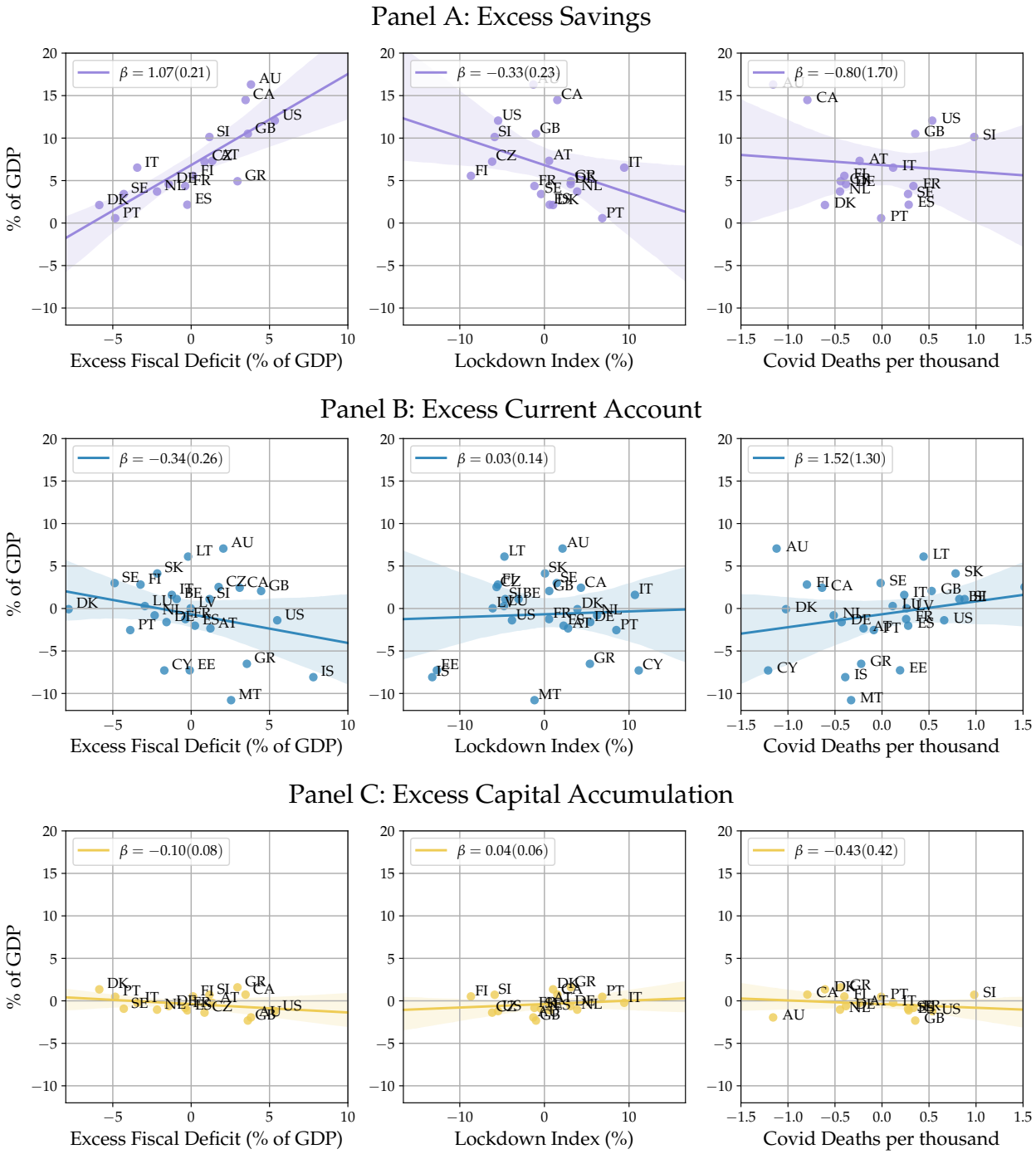
A.4 Identified impulse response following Guajardo et al. (2014)

The figures in this section show the cumulative responses produced by a 1% of GDP increase in the government's primary balance. The budget shock is from Guajardo et al. (2014), who construct it using the narrative approach as in Romer and Romer (2010). To identify policy changes that are potentially exogenous to current economic activity, the authors analyze a wide range of policy documents such as budgets, central banks reports, and IMF Staff Reports. They identify 173 policy changes for 17 OECD countries during 1978-2009 which motivation is to reduce the budget deficit. For details, see Guajardo et al. (2014). We used these policy changes as our measure of fiscal shock.

The two variables of interest are net exports relative to GDP and the government primary balance relative to GDP. In Guajardo et al. (2014), both are measured in first differences, as $g_t^{nx} \equiv \frac{NX_t - NX_{t-1}}{Y_{t-1}}$ and $g_t^{PB} = \frac{PB_t - PB_{t-1}}{Y_{t-1}}$. As measure for the primary balance, we use cyclically adjusted primary balance of the OECD (Guajardo et al. 2014). Results are very similar if the primary balance measure by Alesina and Ardagna (2010) is being used. The cumulative responses are estimated using a Jordà (2005) projection,

$$\sum_{s=0}^{h}\sum_{r=0}^{s} g_{t+r} = \beta shock_t + \sum_{s=1}^{2}\theta_s g_{t-s}^{nx} + \sum_{s=1}^{2}\beta_s g_{t-s}^{PB} + \sum_{s=1}^{2}\mu_s g_{t-s}^{Y} + \delta_i + \gamma_t + \varepsilon_{it}$$

where g_t^Y is real GDP growth; δ_i are country fixed-effects, γ_t are year fixed-effects, $shock_t$ is the narrative fiscal shock. The left-hand side variable, g_{t+r}, is either g^{nx} or g^{PB}. Given that both g^{nx} and g^{PB} are growth rates, a double summation is necessary to obtain the cumulative response on the primary balance and net exports (both as percentages of GDP). All variables are obtained from Guajardo et al. (2014).



Note: β indicates the regression coefficient of the y-axis on the x-axis variable. The latter is the original x axis variable purged of the other two, so that the regression coefficient corresponds to the one in a regression that directly controls for these other variables. The standard error around this coefficient is in parentheses. Shaded areas correspond to 68% bootstrapped confidence intervals.

Figure 18: Determinants of excess savings, investment, and current accounts (with controls)

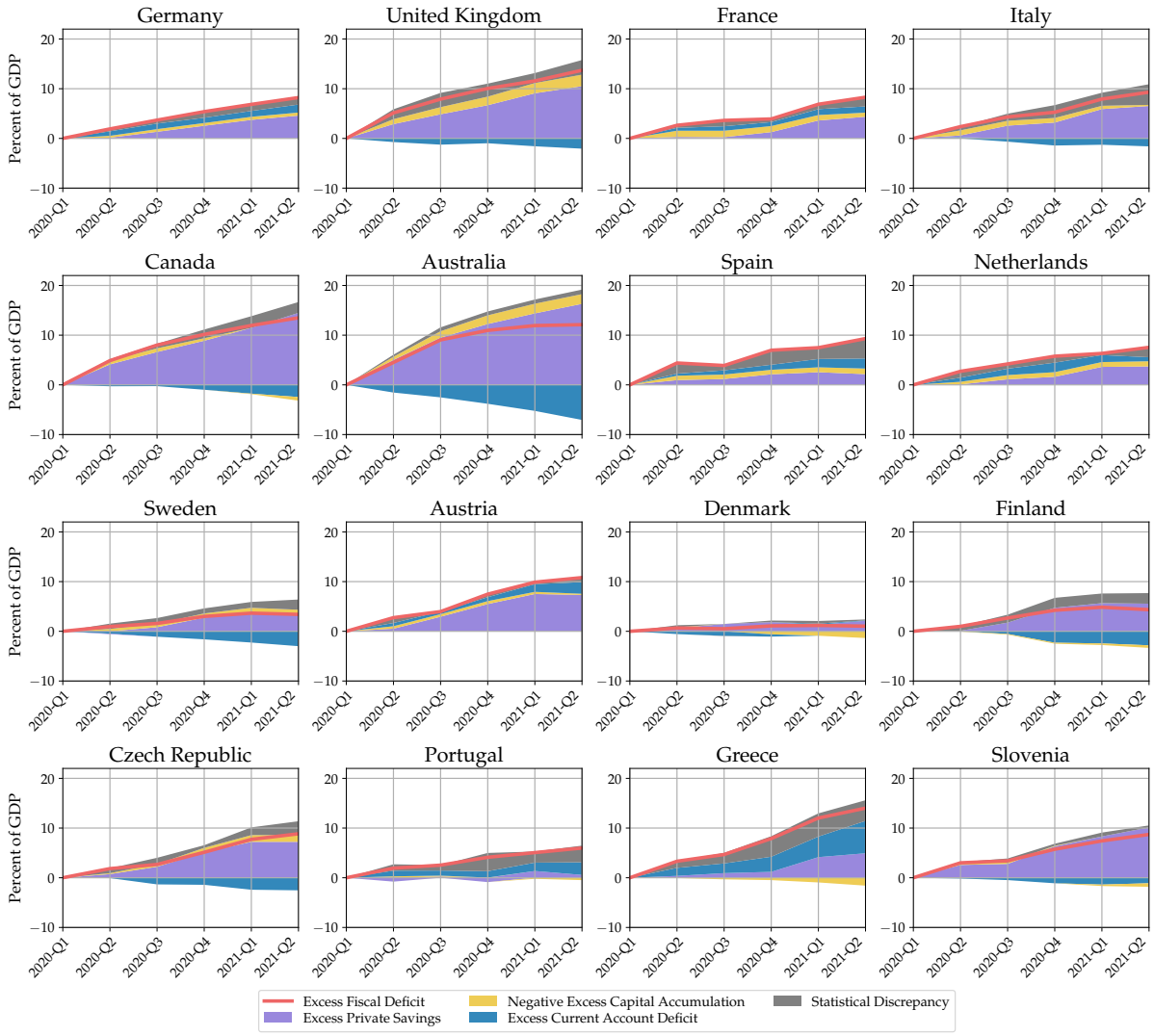


Figure 19: Accounting for fiscal deficits in the Rest of the World

Figure 20: Cumulative Response of Primary Balance

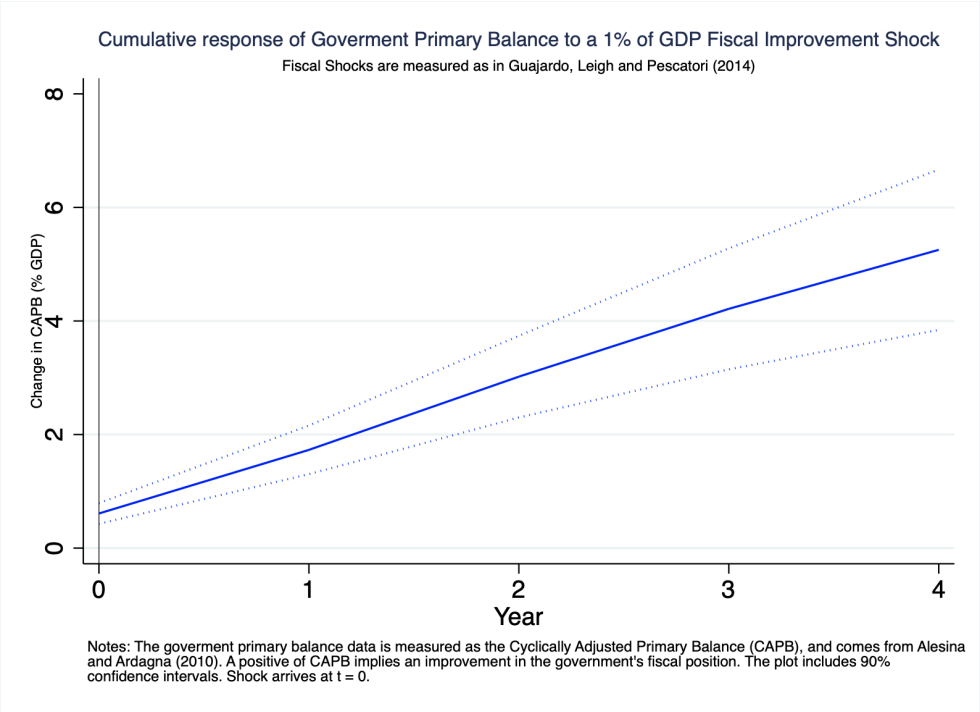


Figure 21: Cumulative response of Net Exports

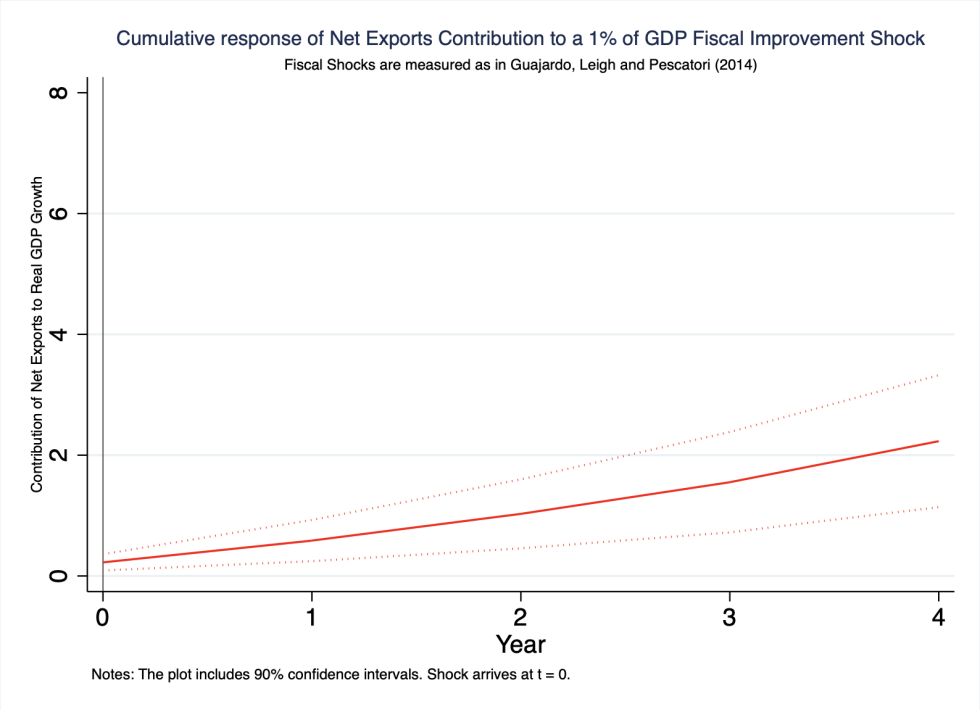
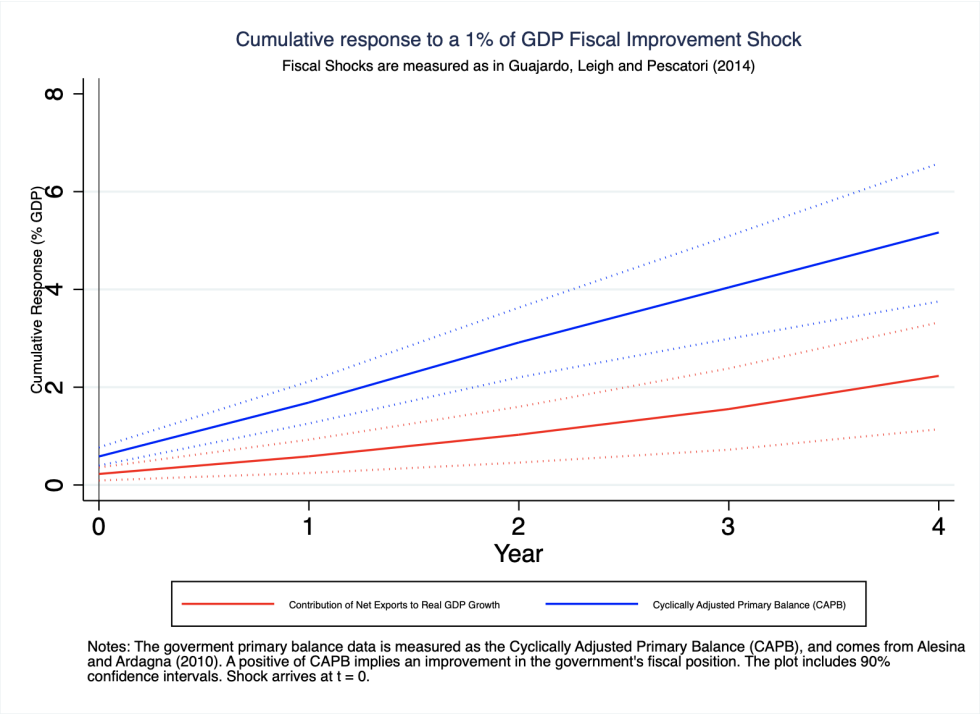


Figure 22: Cumulative response of both Net Exports and CAPB



B Appendix to section 3

B.1 World demand

In each country, imports are given by (12). Therefore, the total demand *received* by country l, summing all countries k, is

$$(C^*_{Ht})^l = \omega^l \cdot \left(\sum_{k=1}^{K} \alpha^k \left(\frac{P^k_{lt}}{P^k_{Wt}} \right)^{-\gamma} \left(\frac{P^k_{Wt}}{P^k_t} \right)^{-\eta} C^k_t \right) \tag{61}$$

Using the law of one price $P_{lt}^k = \frac{\mathcal{E}_t^k}{\mathcal{E}_t^l} P_{Ht}^l$, (17), which for country k reads $P_{Wt}^k = \mathcal{E}_t^k$, and (18), which for country k reads $Q_t^k = \frac{\mathcal{E}_t^k}{P_t^k}$, we have:

$$\begin{aligned}
\left(C_{Ht}^*\right)^l &= \omega^l \cdot \sum_{k=1}^{K} \alpha^k \left(\frac{P_{Ht}^l}{\mathcal{E}_t^l}\right)^{-\gamma} \left(\frac{\mathcal{E}_t^k}{P_t^k}\right)^{-\eta} C_t^k \\
&= \omega^l \cdot \left(\frac{P_{Ht}^l}{\mathcal{E}_t^l}\right)^{-\gamma} \sum_{k=1}^{K} \alpha^k \left(Q_t^k\right)^{-\eta} C_t^k \\
&= \omega^l \cdot \left(\frac{P_{Ht}^l}{P_{Wt}^l}\right)^{-\gamma} C_t^*
\end{aligned}$$

where we have defined world trade as $C_t^* = \sum_{k=1}^{K} \alpha^k \left(Q_t^k\right)^{-\eta} C_t^k$. This gives equations (26) and (27).

B.2 Deriving the current account equation

Start from the aggregate budget constraint (43) and use the market clearing condition (33) at t and $t-1$ to find:

$$\begin{aligned}
C_t + B_t + \text{nfa}_t &= \left(1 + r_t^p\right) A_{t-1} + Z_t \\
&= \left(1 + r_{t-1}\right) A_{t-1} + Z_t + \left(r_t^p - r_{t-1}\right) A_{t-1} \\
&= \left(1 + r_{t-1}\right) B_{t-1} + \left(1 + r_{t-1}\right) \text{nfa}_{t-1} + Z_t + \left(r_t^p - r_{t-1}\right) A_{t-1}
\end{aligned}$$

Use the government budget constraint (20) to obtain:

$$C_t + \frac{P_{Ht}}{P_t} G_t + \text{nfa}_t = \left(1 + r_{t-1}\right) \text{nfa}_{t-1} + Z_t + \frac{P_{Ht}}{P_t} T_t + \left(r_t^p - r_{t-1}\right) A_{t-1}$$

Using the definition of post-tax income (22), we obtain:

$$C_t + \frac{P_{Ht}}{P_t} G_t + \text{nfa}_t = \left(1 + r_{t-1}\right) \text{nfa}_{t-1} + \frac{P_{Ht}}{P_t} Y_t + \left(r_t^p - r_{t-1}\right) A_{t-1}$$

Let the trade deficit be defined as in (34). The net foreign asset position evolves as:

$$\text{nfa}_t = \left(1 + r_{t-1}\right) \text{nfa}_{t-1} - TD_t + \left(r_t^p - r_{t-1}\right) A_{t-1}$$

Finally, apply (29) to see that the last term (the valuation effect on the NFA) is zero. Hence, we obtain the relationship between the current account and the trade deficit:

$$CA_t \equiv \text{nfa}_t - \text{nfa}_{t-1} = r_{t-1}\text{nfa}_{t-1} - TD_t$$

which is equation (35). Observe, moreover, that

$$\begin{aligned} TD_t &= \frac{P_{Ht}}{P_t}C_{Ht} + \frac{P_{Wt}}{P_t}C_{Wt} - \frac{P_{Ht}}{P_t}\left(C_{Ht} + C^*_{Ht}\right) \\ &= \frac{P_{Wt}}{P_t}C_{Wt} - \frac{P_{Ht}}{P_t}C^*_{Ht} \end{aligned} \tag{62}$$

that is, it is the difference between the value of imports $\frac{P_{Wt}}{P_t}C_{Wt}$ and exports $\frac{P_{Ht}}{P_t}C^*_{Ht}$.

B.3 Walras's law for the world

In this appendix, we show that the world export market clearing condition (36) is equivalent to a world goods market condition and a world asset market clearing condition. Start from country-level goods market clearing,

$$Y^k_t - G^k_t = \left(1-\alpha^k\right)\left(\frac{P^k_{Ht}}{P^k_t}\right)^{-\eta} C^k_t + \omega^k \cdot \left(\frac{P^k_{Ht}}{\mathcal{E}^k_t}\right)^{-\gamma} C^*_t$$

multiply by $\frac{P^k_{Ht}}{\mathcal{E}^k_t}$ and sum,

$$\sum_k \frac{P^k_{Ht}}{\mathcal{E}^k_t}\left(Y^k_t - G^k_t\right) = \sum_k \left(1-\alpha^k\right)\frac{P^k_{Ht}}{\mathcal{E}^k_t}\left(\frac{P^k_{Ht}}{P^k_t}\right)^{-\eta} C^k_t + \sum_k \left(\omega^k \cdot \left(\frac{P^k_{Ht}}{\mathcal{E}^k_t}\right)^{1-\gamma}\right) C^*_t$$

using the price consistency condition (37) and export market clearing (36), we find

$$\begin{aligned}
\sum_k \frac{P_{Ht}^k}{\mathcal{E}_t^k}\left(Y_t^k - G_t^k\right) &= \sum_k \left\{\left(1-\alpha^k\right)\frac{P_{Ht}^k}{\mathcal{E}_t^k}\left(\frac{P_{Ht}^k}{P_t^k}\right)^{-\eta} + \alpha^k\left(Q_t^k\right)^{-\eta}\right\} C_t^k \\
&= \sum_k \left\{\left(1-\alpha^k\right)\frac{P_{Ht}^k}{\mathcal{E}_t^k}\frac{\mathcal{E}_t^k}{P_t^k}\left(\frac{P_{Ht}^k}{P_t^k}\right)^{-\eta} + \alpha^k\left(Q_t^k\right)^{1-\eta}\right\}\frac{C_t^k}{Q_t^k} \\
&= \sum_k \left\{\left(1-\alpha^k\right)\left(\frac{P_{Ht}^k}{P_t^k}\right)^{1-\eta} + \alpha^k\left(Q_t^k\right)^{1-\eta}\right\}\frac{C_t^k}{Q_t^k} \\
&= \sum_k \frac{C_t^k}{Q_t^k}
\end{aligned}$$

where the last line follows from the definition of the price index P_t^k in each country. We therefore obtain world goods market clearing (40).

From the current account identify in each country, we have:

$$\text{nfa}_t^k = \left(1 + r_{t-1}^k\right)\text{nfa}_{t-1}^k + \frac{P_{Ht}^k}{P_t^k}\left(Y_t^k - G_t^k\right) - C_t^k$$

so

$$\frac{1}{Q_t^k}\text{nfa}_t^k = \left(1 + r_{t-1}^k\right)\frac{1}{Q_t^k}\text{nfa}_{t-1}^k + \frac{P_{Ht}^k}{\mathcal{E}_t^k}\left(Y_t^k - G_t^k\right) - \frac{P_t^k C_t^k}{\mathcal{E}_t^k}$$

But from the UIP condition in country k, we have: $\frac{1+r_{t-1}^k}{Q_t^k} = \frac{1+i_{t-1}^*}{Q_{t-1}^k}$, where i_t^* is star interest rate, which is common across countries. Hence, NFAs *in units of the common world good* satisfy

$$\frac{\text{nfa}_t^k}{Q_t^k} = \left(1 + i_{t-1}^*\right)\frac{\text{nfa}_{t-1}^k}{Q_{t-1}^k} + \frac{P_{Ht}^k}{\mathcal{E}_t^k}\left(Y_t^k - G_t^k\right) - \frac{P_t^k C_t^k}{\mathcal{E}_t^k} \tag{63}$$

Given world goods market clearing condition (40), and initial asset market clearing $\sum \frac{\text{nfa}_{-1}^k}{Q_{-1}^k} = 0$, we therefore have at each date:

$$\sum_k \frac{\text{nfa}_t^k}{Q_t^k} = 0$$

or equivalently, given $\text{nfa}_t^k = A_t^k - B_t^k$, world asset market clearing:

$$\sum_k \frac{A_t^k}{Q_t^k} = \sum_k \frac{B_t^k}{Q_t^k} \tag{64}$$

B.4 $\alpha \to 1$ limit

In the $\alpha \to 1$ limit, the economy is perfectly open. We have the following relations:

$$\begin{aligned} P_t &= P_{Ft} = \mathcal{E}_t \\ Q_t &= \frac{\mathcal{E}_t}{P_t} = 1 \\ C_{Ft} &= C_t \\ C_{Ht} &= 0 \\ r_t &= r_t^* \end{aligned}$$

Monetary policy has no control over the real interest rate or the real exchange rate. The Fisher equation is also the UIP equation,

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

so the central bank can set the *nominal* interest rate, which affects the nominal exchange rate through the standard overshooting mechanism, and therefore the price index (residents only buy foreign goods, but the country is still producing goods for the rest of the world).

Real after-tax income is now

$$Z_t = \frac{P_{Ht}}{P_t} (Y_t - T_t) = \frac{P_{Ht}}{\mathcal{E}_t} (Y_t - T_t)$$

The goods market clearing condition now reads

$$Y_t = \left(\frac{P_{Ht}}{\mathcal{E}_t} \right)^{-\gamma} C^* + G_t$$

so real income is

$$Z_t = \left(\frac{P_{Ht}}{\mathcal{E}_t} \right)^{1-\gamma} C^* + \frac{P_{Ht}}{\mathcal{E}_t} (G_t - T_t)$$

in other words, it is the sum of export income (a constant when $\gamma = 1$), plus any real value of the primary deficit.

The government budget constraint is:

$$B_t = (1 + r_{t-1}) B_{t-1} + \frac{P_{Ht}}{\mathcal{E}_t} (G_t - T_t)$$

substituting into real income, we obtain:

$$Z_t = \left(\frac{P_{Ht}}{\mathcal{E}_t}\right)^{1-\gamma} C^* + PD_t$$

Domestic price inflation is:

$$\pi_{Ht} = \kappa_w \left(\frac{v'\left(Y_t/\Theta\right) Y_t}{\frac{\epsilon_w}{\epsilon_w - 1}\left(1-\lambda\right)\Theta Z_t u'\left(C_t\left(\{r, Z_s\}\right)\right)} - 1 \right) + \beta \pi_{Ht+1}$$

and net foreign asset dynamics are:

$$\begin{aligned} \text{nfa}_t - \text{nfa}_{t-1} &= r_{t-1}\text{nfa}_{t-1} + \underbrace{\frac{P_{Ht}}{\mathcal{E}_t}\left(Y_t - G_t\right) - C_t}_{NX_t} \\ &= r_{t-1}\text{nfa}_{t-1} + \left(\frac{P_{Ht}}{\mathcal{E}_t}\right)^{1-\gamma} C^* - C_{Ft}\left(\{r, Z_s\}\right) \end{aligned}$$

We consider a monetary policy that targets a constant path for the terms of trade, $\frac{P_{Ht}}{\mathcal{E}_t} = 1$. These equations show that this corresponds to the $\alpha \to 1$ limit of the economy with home bias where monetary policy sets a constant Q.

B.5 Details on the U.S. calibration

Table 4 plots moments of the distribution of wealth in the model vs the data.

% of total wealth held	Gini Coefficient	Top 50%	20%	10%	5%	1%
Data (SCF 2019)	0.85	98.5	87.4	76.5	64.9	37.2
Model (US)	0.79	99.2	83.9	63.0	42.6	13.6

Table 4: Wealth Distribution - Data vs Model

C Appendix to section 4

C.1 Proof of Proposition 1

Proof. Start from the steady state steady state version of (22),

$$Z = \frac{P_H}{P}\left(Y - T\right)$$

We also have the long-run government budget constraint (20), which at $r = 0$ just reads

$$G = T$$

Moreover, from the steady state budget constraint (43) at $r = 0$, we know that we have $C = Z$. Combining the three previous equations, we find that

$$C = Z = \frac{P_H}{P}(Y - G) \tag{65}$$

From steady state goods market clearing (32), we find:

$$Y - G = (1 - \alpha)\left(\frac{P_H}{P}\right)^{-\eta} C + \omega\left(\frac{P_H}{\mathcal{E}}\right)^{-\gamma} C^* \tag{66}$$

where the two relative prices that enter are simple functions of the real exchange rate Q,

$$\frac{P_H}{P} = p_H(Q) \qquad \frac{P_H}{\mathcal{E}} = p_H^*(Q) \tag{67}$$

Multiplying (66) by $\frac{P_H}{P}$, and combining with (65), we obtain:

$$C = \frac{\omega p_H(Q)\left(p_H^*(Q)\right)^{-\gamma} C^*}{1 - (1 - \alpha)\left(p_H(Q)\right)^{1-\eta}} \tag{68}$$

We can also rewrite (65) as

$$Y = G + C/p_H(Q) \tag{69}$$

Finally, from (15), and noting that the natural allocation requires $\pi_w = 0$, we get after plugging in production $N = Y/\Theta$ and $C = Z$, the equation

$$\frac{Y}{\Theta} v'\left(\frac{Y}{\Theta}\right) = \frac{\epsilon_w}{\epsilon_w - 1}(1 - \lambda) C u'(C) \tag{70}$$

Equations (68), (69) and (70) determine long-run C, Y, and Q. If long-run G is unchanged from the initial steady state, then these equations tells us that long-run (C, Y, Q) also are. Then, (65) implies that Z is also unchanged, so equation (33) shows that $A(r, Z)$ is unchanged. It follows that $\Delta B + \Delta \text{nfa} = 0$.

In the case where G changes, we have:

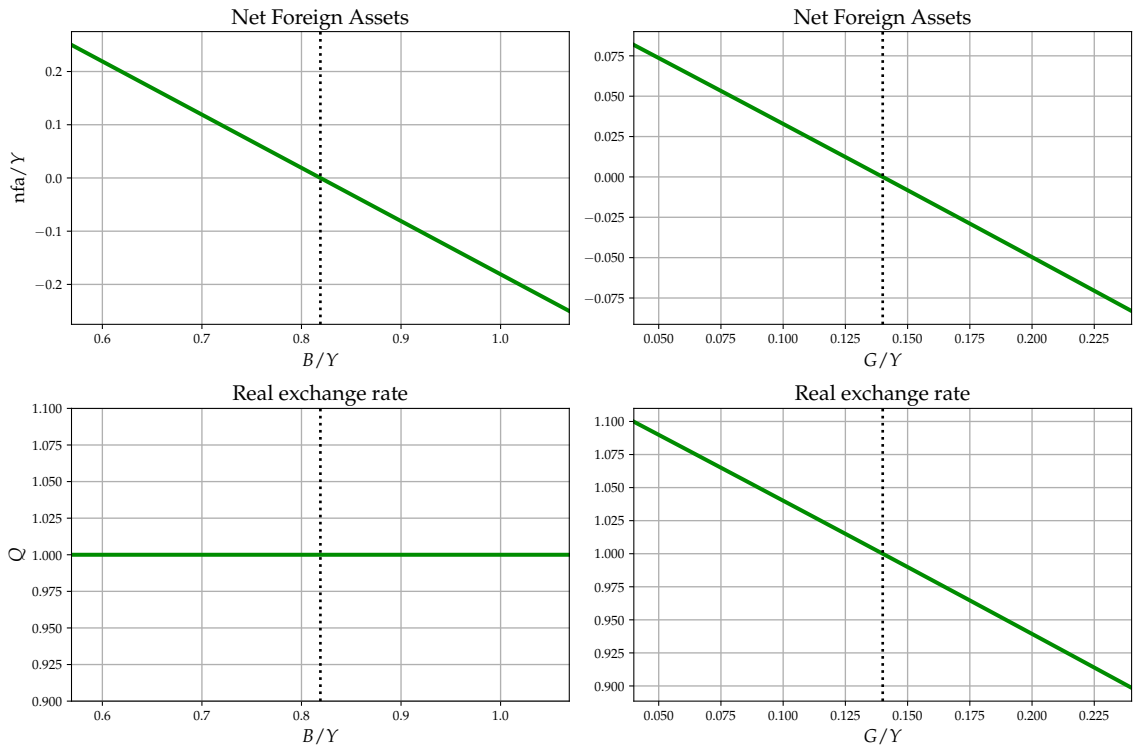


Figure 23: Steady State effect of changing B or G on the RER and the NFA

$$\begin{aligned}
\widehat{C} &= \frac{\chi-\alpha}{1-\alpha}\widehat{Q} \\
\widehat{Y} &= \frac{G}{Y}\widehat{G}+\left(1-\frac{G}{Y}\right)\left(\widehat{C}+\frac{\alpha}{1-\alpha}\widehat{Q}\right) \\
(1+\varphi)\,\widehat{Y} &= (1-\sigma)\,\widehat{C}
\end{aligned}$$

Solving these equations, we obtain:

$$
\begin{aligned}
\widehat{C} &= -\frac{\frac{G}{Y}}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(\frac{\chi+\alpha-1}{\chi-1}\right)}\widehat{G} \\
\widehat{Y} &= \frac{\frac{\sigma-1}{1+\varphi}\frac{G}{Y}}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(\frac{\chi+\alpha-1}{\chi-1}\right)}\widehat{G} \\
\widehat{Q} &= -\frac{\frac{1-\alpha}{\chi-1}\frac{G}{Y}}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(\frac{\chi+\alpha-1}{\chi-1}\right)}\widehat{G} \\
&= -\frac{1-\alpha}{\chi-1}\frac{1}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(\frac{\chi+\alpha-1}{\chi-1}\right)}\frac{dG}{Y}
\end{aligned}
$$

From market clearing, we further have:

$$
\begin{aligned}
dB + d\text{nfa} &= a\left(r\right)dZ = a\left(r\right)dC = A\frac{dC}{C} \\
&= -A\cdot\frac{\frac{G}{Y}}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(\frac{\chi+\alpha-1}{\chi-1}\right)}\widehat{G} \\
&= -A\cdot\frac{1}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(\frac{\chi+\alpha-1}{\chi-1}\right)}\frac{dG}{Y}
\end{aligned}
$$

This implies:

$$
\frac{-d\text{nfa}}{dB} = 1 + \frac{A}{Y}\frac{1}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(\frac{\chi+\alpha-1}{\chi-1}\right)}\frac{dG}{dB}
$$

which delivers the LRPT in the case where $dG \neq 0$. □

C.2 Proof of Proposition 3

Here, we consider the general case where $r \neq 0$ and any monetary policy. We then specialize our results to the case of constant r monetary policy with and $r = 0$.

Preliminaries. Start from the definition of the consumer price index,

$$
P_t = \left[\left(1-\alpha\right)\left(P_{Ht}\right)^{1-\eta} + \alpha\left(P_{Wt}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}
$$

use (17) and (18) to find

$$1 = \left[(1-\alpha) \left(\frac{P_{Ht}}{P_t} \right)^{1-\eta} + \alpha \left(Q_t \right)^{1-\eta} \right]^{\frac{1}{1-\eta}}$$

Differentiating around a steady state with $P_H/P = Q = 1$, we find

$$d\left(\frac{P_{Ht}}{P_t} \right) = -\frac{\alpha}{1-\alpha} dQ_t \tag{71}$$

From (17) and (18), we also have

$$\frac{P_{Ht}}{P_{Wt}} = \frac{P_{Ht}}{\mathcal{E}_t} = \frac{P_{Ht}/P_t}{Q_t}$$

so we also have

$$d\left(\frac{P_{Ht}}{P_{Wt}} \right) = \frac{-1}{1-\alpha} dQ_t \tag{72}$$

Next, define the primary deficit as

$$PD_t \equiv \frac{P_{Ht}}{P_t} \left(G_t - T_t \right) \tag{73}$$

and note that, from the government budget constraint (20), we have

$$PD_t = B_t - \left(1 + r_{t-1} \right) B_{t-1} \tag{74}$$

Combining the definition of real income (22) with (73), we can write real income as:

$$Z_t \equiv \frac{P_{Ht}}{P_t} \left(Y_t - G_t \right) + PD_t \tag{75}$$

Finally, we have the following lemma.

Lemma 1. *We have that:*

$$\frac{\partial C_t}{\partial r_s} \left(\{Z, r\} \right) = Z \frac{\partial C_t}{\partial r_s} \left(\{1, r\} \right) = Z M^r_{t,s}$$

where $M^r_{t,s} \equiv \frac{\partial C_t}{\partial r_s} \left(\{1, r\} \right)$ *is defined as the response of spending to interest rates when steady-state post-tax income is 1, and also*

$$\frac{\partial C_t}{\partial Z_s} \left(\{Z, r\} \right) = \frac{\partial C_t}{\partial Z_s} \left(\{1, r\} \right) = M_{t,s}$$

where $M_{t,s} \equiv \frac{\partial C_t}{\partial Z_s}(\{1, r\})$ *is defined as the response of spending to income when steady-state post-tax income is 1.*

Proof. Follows from the homotheticity of the consumption function $C_t(\{Z_s, r_s\})$ in Z, in the sense that, for any $\lambda \geq 0$, we have:

$$C_t(\{\lambda Z_s, r_s\}) = \lambda C_t(\{Z_s, r_s\}) \tag{76}$$

This equation, in turn, follows from standard homotheticity arguments. □

International fiscal Keynesian cross. Differentiate (75) around the steady state with $\frac{P_H}{P} = 1$, $Y - G = C$, and $PD = -rB$ (the primary deficit is the a surplus large enough to pay for the interest on the debt), to find:

$$\begin{aligned} d\mathbf{Z} &= d\left(\frac{\mathbf{P_H}}{\mathbf{P}}\mathbf{Y}\right) - d\left(\frac{\mathbf{P_H}}{\mathbf{P}}\mathbf{G}\right) + d\mathbf{PD} \\ &= Cd\left(\frac{\mathbf{P_H}}{\mathbf{P}}\right) + d\mathbf{Y} - d\mathbf{G} + d\mathbf{PD} \\ &= -\frac{\alpha}{1-\alpha} Cd\mathbf{Q} + d\mathbf{Y} - d\mathbf{G} + d\mathbf{PD} \end{aligned} \tag{77}$$

Next, differentiate the aggregate consumption function $C_t\left(\{r_s^p, Z_s\}\right)$, using the fact that $r_s^p = r_s$ everywhere from (29), together with lemma 1, to find:

$$d\mathbf{C} = Z\mathbf{M}^r d\mathbf{r} + \mathbf{M} d\mathbf{Z} \tag{78}$$

Substituting (11), (26), and (17) into the goods market clearing condition (32), we obtain:

$$Y_t = (1-\alpha)\left(\frac{P_{Ht}}{P_t}\right)^{-\eta} C_t + \omega\left(\frac{P_{Ht}}{P_{Wt}}\right)^{-\gamma} C_t^* + G_t$$

Differentiating this equation around the steady state where $\alpha C = \omega C^*$, and using (71)–(72) gives

$$\begin{aligned} dY_t &= \left(\alpha C\eta + \omega C^* \cdot \frac{\gamma}{1-\alpha}\right) dQ_t + (1-\alpha)\, dC_t + \omega dC_t^* + G_t \\ &= \alpha\left(\eta + \frac{\gamma}{1-\alpha}\right) CdQ_t + (1-\alpha)\, dC_t + \omega dC_t^* + G_t \end{aligned}$$

hence, denoting $d\mathbf{Y} = (dY_0, dY_1, \ldots)$, we have:

$$d\mathbf{Y} = \frac{\alpha}{1-\alpha}\left(\underbrace{(1-\alpha)\,\eta + \gamma}_{\chi}\right) C d\mathbf{Q} + (1-\alpha)\, d\mathbf{C} + \omega d\mathbf{C}^* + d\mathbf{G} \tag{79}$$

where χ is the trade elasticity, also known as the Marshall-Lerner elasticity (Auclert et al. 2021c).

Collecting equations, we have:

$$\begin{aligned} d\mathbf{C} &= Z\mathbf{M}^r d\mathbf{r} - \frac{\alpha}{1-\alpha} C\mathbf{M} d\mathbf{Q} + \mathbf{M}\left(d\mathbf{Y} - d\mathbf{G} + d\mathbf{PD}\right) \\ d\mathbf{Y} &= \frac{\alpha}{1-\alpha}\chi C d\mathbf{Q} + (1-\alpha)\, d\mathbf{C} + \omega d\mathbf{C}^* + d\mathbf{G} \end{aligned} \tag{80}$$

we can combine to obtain the general equation:

$$\begin{aligned} d\mathbf{Y} = &\left(\underbrace{\frac{\alpha}{1-\alpha}\chi}_{\text{exp. switching}} - \underbrace{\alpha\mathbf{M}}_{\text{real income}}\right) C d\mathbf{Q} + \underbrace{(1-\alpha)\, Z\mathbf{M}^r d\mathbf{r}}_{\text{intertemp. substitution}} \\ &+ \underbrace{\left(I - (1-\alpha)\,\mathbf{M}\right) d\mathbf{G} + (1-\alpha)\,\mathbf{M} d\mathbf{PD}}_{\text{fiscal impulse}} + \underbrace{\omega d\mathbf{C}^*}_{\text{export demand impulse}} \\ &+ \underbrace{(1-\alpha)\,\mathbf{M} d\mathbf{Y}}_{\text{multiplier}} \end{aligned} \tag{81}$$

moreover, the real exchange rate is related to i^* via the UIP condition:

$$d\mathbf{Q} = -\frac{\mathbf{U}}{1+r}\left(d\mathbf{r} - d\mathbf{i}^*\right)$$

where $\mathbf{U}$ is a matrix with 1's on and above the diagonal. Finally, combining (62) with (12) and (26), we obtain:

$$TD_t = \frac{P_{Wt}}{P_t} C_{Wt} - \frac{P_{Ht}}{P_t} C^*_{Ht} = \alpha\left(Q_t\right)^{1-\eta} C_t - \omega\left(Q_t\right)\left(\frac{P_{Ht}}{P_{Wt}}\right)^{1-\gamma} C^*_t$$

Linearizing, and using (72), we find

$$\begin{aligned} dTD_t &= \alpha C\left(1-\eta\right)dQ_t + \alpha dC_t - \omega C^*\left(dQ_t - \frac{(1-\gamma)}{1-\alpha}dQ_t\right) - \omega dC_t^* \\ &= \alpha C\left(1-\eta-1+\frac{1-\gamma}{1-\alpha}\right)dQ_t + \alpha dC_t - \omega dC_t^* \\ &= \frac{\alpha}{1-\alpha}C\left(1-\underbrace{\eta\left(1-\alpha\right)+\gamma}_{\chi}\right)dQ_t + \alpha dC_t - \omega dC_t^* \end{aligned}$$

hence

$$d\mathbf{TD} = \frac{-\alpha}{1-\alpha}C\left(\chi-1\right)d\mathbf{Q} + \alpha d\mathbf{C} - \omega d\mathbf{C}^* \tag{82}$$

Other things equal, a depreciation worsens the trade deficit if $\chi > 1$. More local demand $d\mathbf{C}$ also worsens the trade deficit since it increases imports. An exogenous increase in foreign demand $d\mathbf{C}^*$ raises exports and lowers the trade deficit.

Constant-r monetary policy In the case of a small open economy, with $d\mathbf{i}^* = d\mathbf{C}^* = 0$, and constant-$r$ monetary policy, we have $d\mathbf{r} = d\mathbf{Q} = 0$. Then (81) specializes to

$$d\mathbf{Y} = \left(I-\left(1-\alpha\right)\mathbf{M}\right)d\mathbf{G} + \left(1-\alpha\right)\mathbf{M}d\mathbf{PD} + \left(1-\alpha\right)\mathbf{M}d\mathbf{Y} \tag{83}$$

Solving this delivers:

$$d\mathbf{Y} = d\mathbf{G} + \left(1-\alpha\right)\left(I-\left(1-\alpha\right)\mathbf{M}\right)^{-1}\mathbf{M}d\mathbf{PD} \tag{84}$$

Using this solution into (80) gives

$$\begin{aligned} d\mathbf{C} &= \mathbf{M}\left(d\mathbf{Y} - d\mathbf{G} + d\mathbf{PD}\right) \\ &= \mathbf{M}\left(I-\left(1-\alpha\right)\mathbf{M}\right)^{-1}\left(\left(1-\alpha\right)\mathbf{M} + I - \left(1-\alpha\right)\mathbf{M}\right)d\mathbf{PD} \\ &= \mathbf{M}\left(I-\left(1-\alpha\right)\mathbf{M}\right)^{-1}d\mathbf{PD} \end{aligned}$$

and using this into (82) gives the general twin deficit equation relating the *primary deficit* to the *trade deficit:*

$$d\mathbf{TD} = -\alpha\mathbf{M}\left(I-\left(1-\alpha\right)\mathbf{M}\right)^{-1}d\mathbf{PD}$$

Special case with $r = 0$. Around $r = \text{nfa} = 0$, we have from (35) that

$$d\mathbf{CA} = -d\mathbf{TD}$$

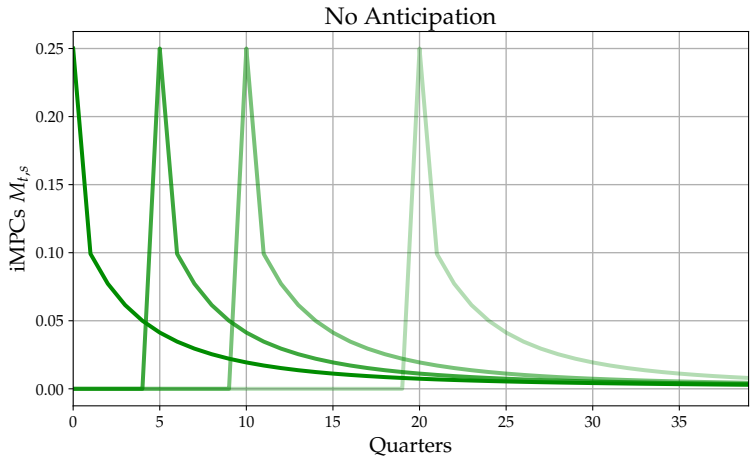


Figure 24: Intertemporal marginal propensities to consume in the no-anticipation model

Moreover, differentiating (74) we find $dPD_t = dB_t - dB_{t-1} - Bdr_{t-1} = dFD_t - Bdr_{t-1}$. In turn, with $d\boldsymbol{r} = 0$ we obtain:

$$d\mathbf{PD} = d\mathbf{FD}$$

Plugging this into (84) gives equation (50), hence, in this case the twin deficit equation can also be written as a relationship between the *current account deficit* $-d\mathbf{CA}$ and the fiscal deficit $d\mathbf{FD}$,

$$-d\mathbf{CA} = -\alpha\mathbf{M}\left(I - (1-\alpha)\,\mathbf{M}\right)^{-1} d\mathbf{FD}$$

which is equation (51).

C.3 No-anticipation model

Here we describe the no-anticipation model. The the $\mathbf{M}$ matrix is given by

$$\mathbf{M}^{na} = \begin{pmatrix} M_{00} & 0 & 0 & \\ M_{01} & M_{00} & 0 & \\ M_{02} & M_{01} & M_{00} & \\ \vdots & \vdots & \vdots & \ddots \end{pmatrix} \tag{85}$$

Figure 24 shows the iMPCs in this case. This would be the outcome, for instance, of adding sticky expectations to our baseline model as in Auclert, Rognlie and Straub (2020), if expectations were perfectly sticky.

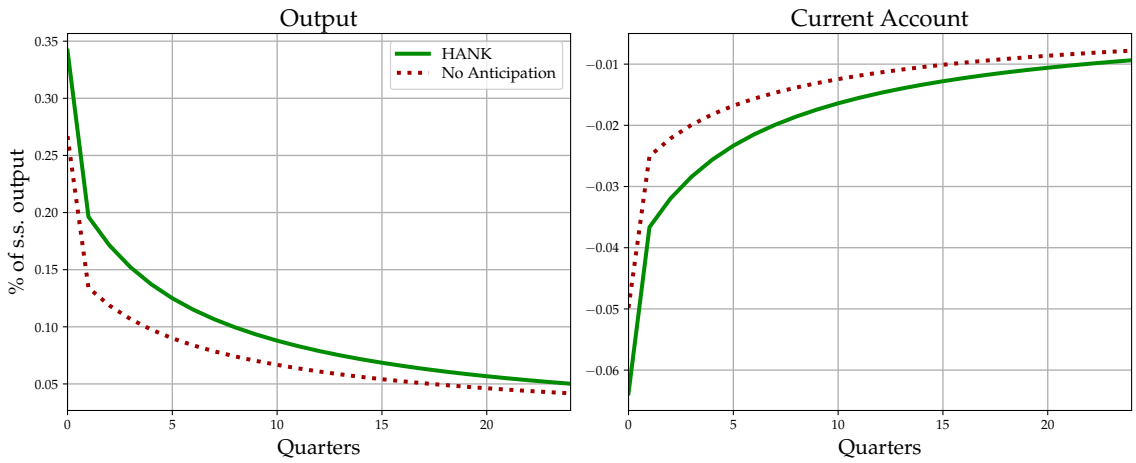


Figure 25: Impulse response to a transfer: main model vs model with $\mathbf{M}^{na}$

Applying equations (50)–(51) to this model, we find:

$$\begin{aligned} dY_0 &= \frac{(1-\alpha)\cdot mpc}{1-(1-\alpha)\,mpc}dB \\ dCA_0 &= -\frac{\alpha\cdot mpc}{1-(1-\alpha)\,mpc}dB \end{aligned}$$

Now we see the exact effect of income adjustment on both GDP and the current account. Figure 25 provides the general equilibrium simulation, we see that the no-anticipation model has slightly lower output and current response throughout, but the time paths are otherwise similar.

C.4 Case with $r \neq 0$

Long-run passthrough. We mirror the proof of Proposition 1, highlighting the places where $r \neq 0$ makes a difference. Start from

$$a(r)\,Z = \text{nfa} + B$$

and use the fact that the budget constraint implies $C = rA + Z$, so $Z = C - rA$. Hence, we get

$$a(r)\,(C - r\,(\text{nfa} + B)) = \text{nfa} + B$$

so

$$A = \frac{a(r)}{1 + ra(r)}C = \text{nfa} + B$$

The long-run government budget constraint (20) is now

$$\frac{P_H}{P}(T-G)=rB$$

The steady state budget constraint (43) now implies

$$\begin{aligned} C &= rA+Z \\ &= rA+\frac{P_H}{P}(Y-T) \\ &= r\text{nfa}+p_H(Q)(Y-G) \end{aligned} \tag{86}$$

where we have substituted in the government budget constraint, asset market clearing $A = B + \text{nfa}$, and the relation $p_H(Q)$ between the relative price P_H/P and the real exchange rate Q. Multiplying the goods market clearing condition (66) by $\frac{P_H}{P}$, and combining, we now have:

$$C=\frac{r\text{nfa}+\alpha p_H(Q)\left(p_H^*(Q)\right)^{-\gamma}C^*}{1-(1-\alpha)\left(p_H(Q)\right)^{1-\eta}} \tag{87}$$

which replaces equation (68). We can also write (86) as

$$Y=G+(C-r\text{nfa})/p_H(Q) \tag{88}$$

which replaces equation (69). Finally (15) at $\pi_w = 0$, replacing $Z = \frac{C}{1+ra(r)}$,

$$\frac{Y}{\Theta}v'\left(\frac{Y}{Y}\right)=\frac{\epsilon_w}{\epsilon_w-1}(1-\lambda)\frac{C}{1+ra(r)}u'(C) \tag{89}$$

which replaces (70). Differentiating starting from $\text{nfa} = 0$, we get

$$\begin{aligned} \widehat{C} &= \frac{r}{\alpha}d\text{nfa}+\frac{\chi-1}{1-\alpha}\widehat{Q} \\ \widehat{Y} &= \frac{G}{Y}\widehat{G}+\left(1-\frac{G}{Y}\right)\left(\widehat{C}-rd\text{nfa}+\frac{\alpha}{1-\alpha}\widehat{Q}\right) \\ \widehat{Y} &= \frac{1-\sigma}{1+\varphi}\widehat{C} \\ dB+d\text{nfa} &= A\cdot\widehat{C} \end{aligned}$$

which gives us a system of 4 equations in 4 unknowns $\left(\widehat{C}, \widehat{Q}, \widehat{Y}, d\text{nfa}\right)$ as a function of dB, dG. The solution is given by

$$d\text{nfa}\left(\frac{rA\left(1-\frac{G}{Y}\right)\left(1+\frac{1}{\chi-1}\right)}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(1+\frac{\alpha}{\chi-1}\right)}-1\right)=dB+\frac{A}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(1+\frac{\alpha}{\chi-1}\right)}\frac{dG}{Y}$$

which gives, in the case of $dG = 0$,

$$LRPT=\frac{d\text{nfa}}{dB}=\frac{1}{1-\frac{rA\left(1-\frac{G}{Y}\right)\left(1+\frac{1}{\chi-1}\right)}{\frac{\sigma-1}{1+\varphi}+\left(1-\frac{G}{Y}\right)\left(1+\frac{\alpha}{\chi-1}\right)}}$$

which is, in general, greater than 1.

Dynamics. Section C.2 covered the proof in the general case with $r \neq 0$. To summarize, Proposition 3 holds provided that we replace the fiscal deficit $d\mathbf{FD}$ by the primary deficit $d\mathbf{PD}$ and the current account deficit $-d\mathbf{CA}$by the trade deficit $d\mathbf{TD}$.

C.5 TANK model

In the TANK model, a fraction $1-\mu$ behaves like infinitely-lived unconstrained agents (u) and fraction μ behaves like hand-to-mouth constrained agents. The Euler equation and budget constraint for the unconstrained households are, respectively:

$$\begin{aligned} C_{u,t}^{-\sigma} &= \beta\left(1+r_{t+1}^{p}\right)C_{u,t+1}^{-\sigma} \\ A_{u,t} &= \left(1+r_{t}^{p}\right)A_{u,t-1}+Z_{t}-C_{u,t} \end{aligned}$$

while constrained household just consume their income,

$$C_{c,t}=Z_{t}$$

Aggregation implies

$$\begin{aligned} C_{t} &= \mu Z_{t}+(1-\mu)C_{u,t} \\ A_{t} &= \mu\times 0+(1-\mu)A_{u,t} \end{aligned}$$

In steady state, $C_t = C$, $Z_t = Z$ and $C_{u,t} = C_u$, implying giving $\beta\left(1+r^p\right)=1$. With $r=0$, we have:

$$\begin{aligned} C_{u,t} &= \overline{C_u} = C_u^{ss} \\ A_{u,t} &= A_{u,t-1} + Z_t - C_u^{ss} \end{aligned} \tag{90}$$

Since $Z_t = Y_t - T_t$ where $T_t = B_{t-1} - B_t + G_t$. As a result, we have

$$\begin{aligned} C_t &= \mu Z_t + (1-\mu) C_u^{ss} \\ &= \mu\left(Y_t - T_t\right) + (1-\mu) C_u^{ss} \end{aligned} \tag{91}$$

At constant r, we have $Q=1$. Goods market clearing

$$\omega C^* + (1-\alpha) C_t = Y_t - G_t$$

combined with (91) implies

$$\frac{1}{1-\alpha}\left(Y_t - G_t - C^* C^*\right) = \mu\left(Y_t - T_t\right) + (1-\mu) C_u^{ss}$$

solving out, , we obtain

$$Y_t = \frac{1-\alpha}{1-\mu(1-\alpha)}\left((1-\mu) C_u^{ss} + \frac{\omega}{1-\alpha} C^* + \frac{1}{1-\alpha} G_t - \mu T_t\right)$$

We can write this in terms of the fiscal deficit $FD_t = G_t - T_t$ as $T_t = G_t - FD_t$, as

$$Y_t = \frac{(1-\alpha)(1-\mu) C_u^{ss} + \omega C^*}{1-\mu(1-\alpha)} + G_t + \frac{\mu(1-\alpha)}{1-\mu(1-\alpha)} FD_t$$

which implies in particular

$$d\boldsymbol{Y} = d\boldsymbol{G} + \frac{\mu(1-\alpha)}{1-\mu(1-\alpha)} d\boldsymbol{FD} \tag{92}$$

as claimed in the text. Moreover, we have:

$$\begin{aligned} Z_t &= Y_t - T_t \\ &= \frac{(1-\alpha)(1-\mu) C_u^{ss} + \omega C^*}{1-\mu(1-\alpha)} + \left(1 + \frac{\mu(1-\alpha)}{1-\mu(1-\alpha)}\right) FD_t \\ &= \frac{(1-\alpha)(1-\mu) C_u^{ss} + \omega C^*}{1-\mu(1-\alpha)} + \frac{1}{1-\mu(1-\alpha)} FD_t \end{aligned}$$

Substitute in asset dynamics (90) to get

$$\begin{aligned} A_t - A_{t-1} &= (1-\mu)\left(A_{u,t} - A_{u,t-1}\right) \\ &= (1-\mu)\left(Z_t - C_u^{ss}\right) \\ &= \frac{1-\mu}{1-\mu(1-\alpha)} FD_t \end{aligned}$$

This implies that the current account is

$$CA_t = \text{nfa}_t - \text{nfa}_{t-1} = A_t - A_{t-1} - FD_t = \left(\frac{1-\mu}{1-\mu+\alpha\mu} - 1\right) = \frac{-\mu\alpha}{1-\mu(1-\alpha)} FD_t$$

implying in particular:

$$-d\boldsymbol{CA} = \frac{\mu\alpha}{1-\mu(1-\alpha)} d\boldsymbol{FD} \tag{93}$$

Equations (92) and (93) show that, for TANK, proposition 3 applies with $\boldsymbol{M} = \mu \boldsymbol{I}$.

To see what this implies for the steady state, integrate the asset equation. This shows:

$$\Delta A = \frac{1-\mu}{1-\mu(1-\alpha)} \Delta B \tag{94}$$

$$\Delta \text{nfa} = \frac{-\mu\alpha}{1-\mu(1-\alpha)} \Delta B \tag{95}$$

where the Δ applies between any time t and the initial steady state, and in particular between the initial and the final steady state.

In particular, we have:

$$LPRT = -\frac{\Delta \text{nfa}}{\Delta B} = \frac{\mu\alpha}{1-\mu(1-\alpha)}$$

To draw Figure 12, we calibrate μ to a certain $mpc_0 = 0.25$ and $\alpha = 0.16$, as in our main model. The TANK model does not have another degree of freedom for MPCs.

C.6 Blanchard model

Here we consider a discrete-time version of the Blanchard (1985) model. This is one of the simplest models of non-Ricardian agents that can be consistent with the data on iMPCs.

The model is as follows. Agents have infinite planning horizons, discount the future at rate β, and have a constant probability of death each period. Specifically, their probability of surviving to period t is $\Phi_t = \phi^t$, where ϕ is the (constant) period survival probability which here is taken to be a constant. This setting implies that agents' expected lifetime is

$\frac{1}{1-\phi}$. Moreover, in a stationary distribution, the size of a cohort of age j is proportional to ϕ^j. Since $\sum \phi^a = \frac{1}{1-\phi}$, the share of agents of age j is $\pi_j = (1-\phi)\,\phi^j$.

The model is set up such that there is no within-cohort heterogeneity: all agents aged j at time t (so from the same cohort $k = t - j$) receive the same income $z_{j,t}$. However, there is a lot of heterogeneity across-cohort.

Specifically, the problem of an agent born in cohort k, going through ages $j = t - k$ (where t denotes calendar time) is:

$$\begin{aligned} \max \quad & E_k \left[\sum_j \beta^j \phi^j \log\left(c_{jt}\right) \right] \\ s.t. \quad & c_{j,t} + a_{j+1,t+1} = \frac{(1+r_t)}{\phi} a_{j,t} + z_{j,t} \end{aligned} \tag{96}$$

where $z_{j,t}$ is post-tax income of an agent aged j at time t. Here, agents have access to annuities $a_{j,t}$ that pay a return $\frac{(1+r_t)}{\phi}$ conditional on not dying, such that the assets of the dying are distributed equally among the remaining members of the cohort.

We consider the extension of the canonical Blanchard model in which age profiles decay with age at rate ζ:

$$z_{j,t} \propto (1-\zeta)^j Z_t \tag{97}$$

where Z_t denotes aggregate income. This front-loaded income profile generates a life-cycle motive to save, which is essential to deliver positive asset accumulation in the steady state at $r = 0$ (the canonical Blanchard model then corresponds to $\zeta = 0$).

Given log utility and the presence of annuities, individual consumption follows

$$c_{j,t} = (1 - \phi\beta) \frac{(1+r_t)}{\phi} \left(a_{j,t} + h_{j,t}\right) \tag{98}$$

where human capital is given by:

$$h_{j,t} = \frac{\phi}{1+r_t} \left(z_{j,t} + (1-\zeta)\, h_{j+1,t+1}\right) \tag{99}$$

This leads us the the following proposition.

Proposition 7. *Aggregate dynamics in the Blanchard model are given by the asset demand function* $A_t = A_t\left(\{r_s, Z_s\}\right)$ *and the consumption function* $C_t = C_t\left(\{r_s, Z_s\}\right)$ *that solve the system*

of three equations:

$$H_t = \frac{\phi}{1+r_t}\left(Z_t + (1-\zeta)\, H_{t+1}\right) \tag{100}$$

$$C_t = (1-\phi\beta)\,\frac{(1+r_t)}{\phi}\left(A_{t-1} + H_t\right) \tag{101}$$

$$C_t + A_t = (1+r_t)\, A_{t-1} + Z_t \tag{102}$$

Moreover, the long-run asset demand curve is given by:

$$A = a(r)\, Z \qquad \textit{where} \qquad a(r) = \frac{1-(1-\phi\beta)\,\frac{1+r}{1+r-\phi(1-\zeta)}}{(1-\phi\beta)\,\frac{(1+r)}{\phi} - r}$$

Proposition (7), which follows from aggregation of equations (99), (98) and (96), respectively, using the stationary distribution $\pi_j = (1-\phi)\,\phi^j$, is the discrete-time counterpart of equations (19)–(21) in Blanchard (1985).

We can further characterize analytically the steady state dynamics implied by equation (7), i.e. the Jacobians of the A and C functions. We focus on the first column of $M = \frac{\partial C_t}{\partial Z_s}$, since this gives us the dynamic MPCs from unexpected income shocks that we can calibrate the model to. It is possible to show:

Proposition 8. *In the Blanchard model, the first column of the M matrix is given by*

$$M_{t,0} = \frac{\partial C_t}{\partial Z_0} = \begin{cases} (1-\beta\phi) & t = 0 \\ (1-\beta\phi)\,\beta\left(1+\beta-\frac{1}{\phi}\right)^t & t > 0 \end{cases}$$

Note that ζ does not appear in these equations—instead, ζ controls the degree of anticipation of future income shocks.

Given Proposition 8, we calibrate the household side of the Blanchard model by picking (β, ϕ) jointly to hit $mpc_0 = 0.25$ and a certain target for mpc_1. Given the constraint that $\phi < 1$, Proposition 8 implies that we must pick $mpc_0\,(1-mpc_0) < mpc_1$. We choose $mpc_1 = 0.2$. We then pick $\alpha = 0.16$ as in our main calibration. This delivers Figure 12.

C.7 Bond-in-utility model

Here, we set up a bond-in-the utility model. We then show that, for its response to income, this model is first-order equivalent to the Blanchard model.

The agent maximizes the objective

$$\sum \beta^t \left\{ u\left(C_t\right) + v\left(A_t\right) \right\}$$

where v is a love-of-asset function, subject to the same aggregate budget constraint as in our main HANK model, (43). The Euler equation for this problem is:

$$u'\left(C_t\right) = \beta\left(1 + r_{t+1}\right) u'\left(C_{t+1}\right) + v'\left(A_t\right) \tag{103}$$

and the steady state is characterized by:

$$u'\left(rA + Z\right)\left(1 - \beta\left(1 + r\right)\right) = v'\left(A\right)$$

Assuming homothetic utility $u'\left(c\right) = c^{-\sigma}$, $v'\left(a\right) = a^{-\sigma}$, this can be rewritten as:

$$\left(r + \frac{Z}{A}\right) = \left(1 - \beta\left(1 + r\right)\right)^{\frac{1}{\sigma}}$$

Hence, the steady-state asset demand function is

$$A = a\left(r\right) Z$$

where, here:

$$a\left(r\right) = \frac{A}{Z} = \frac{1}{\left(1 - \beta\left(1 + r\right)\right)^{\frac{1}{\sigma}} - r}$$

The dynamics at a constant real rate r can be characterized by differentiating (103) and (43). This delivers:

$$\begin{aligned} u''\left(C\right) dC_t &= \beta\left(1 + r\right) u''\left(C\right) dC_{t+1} + v''\left(A\right) dA_{t+1} \\ dC_t + dA_{t+1} &= \left(1 + r\right) dA_t + dZ_t \end{aligned}$$

Combining, we obtain:

$$\beta\left(1 + r\right) dA_{t+1} - \left(1 + \frac{v''\left(A\right)}{u''\left(C\right)} + \beta\left(1 + r\right)^2\right) dA_t + \left(1 + r\right) dA_{t-1} = -dZ_t + \beta\left(1 + r\right) dZ_{t+1}$$

which we rearrange as:

$$dA_{t+1} - \frac{1}{\beta(1+r)}\left(1 + \frac{v''(A)}{u''(C)} + \beta(1+r)^2\right) dA_t + \frac{1}{\beta} dA_{t-1} = -\frac{1}{\beta(1+r)} dZ_t + dZ_{t+1} \tag{104}$$

Let λ and $\frac{1}{\beta\lambda}$ be the roots of

$$C(X) = X^2 - \frac{1}{\beta(1+r)}\left(1 + \frac{v''(A)}{u''(C)} + \beta(1+r)^2\right) X + \frac{1}{\beta}$$

Then (104) rewrites as

$$dA_{t+1} - \left(\lambda + \frac{1}{\beta\lambda}\right) dA_t + \frac{1}{\beta} dA_{t-1} = -\frac{1}{\beta(1+r)} dZ_t + dZ_{t+1}$$

This leads us to the following.

Proposition 9. *Assume that the bond-in-the-utility model is parameterized such that*

$$\begin{aligned} \beta^{BU} &= \frac{1}{\left(\frac{1+r}{\phi}\right)^2 \frac{1}{1-\zeta}\left(\phi(1+\beta) - 1\right)} \\ \frac{1}{\beta^{BU}(1+r^{BU})} &= \frac{\beta\phi}{\kappa} \end{aligned}$$

and that $\frac{v''(A)}{u''(C)}$ is picked so that $\lambda^{BU} = \frac{1}{\kappa}$. Then, the BU model and the Blanchard model share the same **M** *matrix, that is, to first order they have identical responses to income shocks at any date.*

C.8 Covid shock to home spending

As mentioned in the text, to model the Covid shock to home spending, we modify the household problem so that consumption is defined as:

$$c_{it}^k = \left[\left(\left(1-\alpha^k\right)\right)^{\frac{1}{\eta}} \left(\zeta_t c_{iHt}^k\right)^{\frac{\eta-1}{\eta}} + \left(\alpha^k\right)^{\frac{1}{\eta}} \left(c_{iWt}^k\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

Given this new definition, equation (9) is modified to be

$$\begin{aligned} V_t(A,e) \quad &= \quad \max_{c_F,c_H,a'} u\left(c_t\left(c_H,c_W\right)\right) - v\left(N_t\right) + \beta \mathbb{E}_t\left[V_{t+1}\left(A',e'\right)\right] \\ &\text{s.t.} \quad P_{Ht}c_H + \sum_{l=1}^{K} P_{lt}c_W^l + A' = \left(1+r_t^p\right)\frac{P_t}{P_{t-1}}A + P_t \cdot \nu_t\left(e\frac{W_t}{P_t}N_t\right)^{1-\lambda} \\ &\quad A' \geq 0 \end{aligned} \tag{105}$$

This gives rise to a new demand system:

$$c_H \quad = \quad (1-\alpha)\left(\frac{P_H}{\zeta P^{mod}}\right)^{-\eta}\frac{c}{\zeta} \qquad c_F = \alpha\left(\frac{P_{Ft}}{P^{mod}}\right)^{-\eta} c \tag{106}$$

where P^{mod}, the modified price index, is given by

$$P^{mod} = \left[(1-\alpha)\left(\frac{P_H}{\zeta}\right)^{1-\eta} + \alpha\left(P_W\right)^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{107}$$

with the Cobb Douglas limit $\eta = 1$ being $P^{mod} = \left(\frac{P_H}{\zeta}\right)^{1-\alpha}\left(P_W\right)^{\alpha}$.

We can modify the household problem as follows. The household perceives real post-tax income to be equal to

$$\frac{e^{1-\lambda}}{\mathbb{E}\left[e^{1-\lambda}\right]}\frac{Z_t}{P_t^{mod}/P_t}$$

which effectively implies that it perceives real income to be $Z_t^{mod} = \frac{Z_t}{P_t^{mod}/P_t}$. Similarly, it perceives the ex-post real interest rate to be:

$$1 + r_t^{mod,post} = \left(1 + r_t^{post}\right)\cdot\frac{P_{t-1}^{mod}/P_{t-1}}{P_t^{mod}/P_t}$$

Given the paths $\left\{r_t^{mod}, P_t^{mod}\right\}$, households solve their problem to determine consumption c^{mod}, then allocates demand per (106), ie:

$$c_H = (1-\alpha)\left(\frac{P_H}{\zeta P^{mod}}\right)^{-\eta}\frac{c^{mod}}{\zeta} \qquad c_F = \alpha\left(\frac{P_{Ft}}{P^{mod}}\right)^{-\eta} c^{mod}$$

We obtain $\frac{P^{mod}}{P}$ from:

$$\frac{P^{mod}}{P} = \left(\frac{(1-\alpha)\left(\frac{P_H}{\zeta}\right)^{1-\eta} + \alpha\left(P_W\right)^{1-\eta}}{(1-\alpha)\left(P_H\right)^{1-\eta} + \alpha\left(P_W\right)^{1-\eta}} \right)^{\frac{1}{1-\eta}} = \left(\frac{(1-\alpha)\left(\frac{1}{\zeta}\right)^{1-\eta} + \alpha\left(\frac{P_W}{P_H}\right)^{1-\eta}}{(1-\alpha)\left(1\right)^{1-\eta} + \alpha\left(\frac{P_W}{P_H}\right)^{1-\eta}} \right)^{\frac{1}{1-\eta}}$$

as well as the relevant relative prices from:

$$\frac{P_H}{P^{mod}} = \frac{P_H}{P} \cdot \frac{1}{P^{mod}/P} \quad \frac{P_F}{P^{mod}} = \frac{P_F}{P} \cdot \frac{1}{P^{mod}/P}$$

Finally we can recreate aggregate c using:

$$\frac{P_H}{P} c_H + \frac{P_F}{P} c_F$$

D Appendix to sections 5 and 6

D.1 Proof of Proposition 4

TO BE ADDED. Figure 26 illustrates the quality of the approximation.

D.2 Proof of Propositions 5 and 6

Proof of Proposition 2. . The International Keynesian Cross (IKC) for individual country is:

$$\begin{aligned} d\boldsymbol{C}^k &= C^k M^r d\boldsymbol{i}^* + M \cdot \left(d\boldsymbol{Y}^k - d\boldsymbol{T}^k \right) \\ d\boldsymbol{Y}^k &= (1-\alpha)\, d\boldsymbol{C}^k + \omega^k d\boldsymbol{C}^* + d\boldsymbol{G}^k \end{aligned}$$

where $M^r = \frac{\partial \log C_t^r}{\partial r_s}$ and $M = \frac{\partial C_t^k}{\partial Y_s}$ are the same in each country k. Given $d\boldsymbol{i}^*$ common everywhere, we obtain:

$$\begin{aligned} d\tilde{\boldsymbol{C}}^k &= M \cdot \left(d\tilde{\boldsymbol{Y}}^k - d\tilde{\boldsymbol{T}}^k \right) \\ d\tilde{\boldsymbol{Y}}^k &= (1-\alpha)\, d\tilde{\boldsymbol{C}}^k + d\tilde{\boldsymbol{G}}^k \end{aligned}$$

this is the small open economy IKC at constant real rates. This applies to every aggregate, in particular to NFAs, which have mean 0 since the impulse to $\widetilde{B}$ is mean 0. □

Country	Code	α	ω	MPC_0	β	Δ	MPC_1	Top 20% wealth share
United States	US	15.7	27.8	0.25	0.99	0.1	0.1	83.9
Germany	DE	54.2	16.2	0.25	0.99	0.1	0.1	84.2
United Kingdom	GB	37	8.6	0.25	0.99	0.1	0.1	84.2
France	FR	41.1	7.9	0.25	0.99	0.1	0.1	84.4
Italy	IT	35.8	5.1	0.25	0.99	0.1	0.1	84.1
Canada	CA	41.5	5.2	0.25	0.99	0.1	0.1	84.3
Australia	AU	26.4	2.7	0.25	0.99	0.1	0.1	84.1
Spain	ES	40.6	4.1	0.25	0.99	0.1	0.1	84.2
Netherlands	NL	90	5.9	0.25	0.99	0.1	0.1	84.5
Sweden	SE	58.3	2.2	0.25	0.99	0.1	0.1	84.5
Belgium	BE	90	3.5	0.25	0.99	0.1	0.1	84.4
Austria	AT	65.1	2.2	0.25	0.99	0.1	0.1	84.3
Denmark	DK	69.6	1.8	0.25	0.99	0.1	0.1	84.5
Finland	FI	49	0.9	0.25	0.99	0.1	0.1	84.4
Czech Republic	CZ	90	1.7	0.25	0.99	0.1	0.1	84.2
Portugal	PT	50.5	0.9	0.25	0.99	0.1	0.1	84.1
Greece	GR	45.6	0.6	0.25	0.99	0.1	0.1	84.3
Slovakia	SK	90	0.7	0.25	0.99	0.1	0.1	84.2
Luxembourg	LU	90	0.5	0.25	0.99	0.1	0.1	84.1
Lithuania	LT	86	0.4	0.25	0.99	0.1	0.1	84.2
Slovenia	SI	90	0.4	0.25	0.99	0.1	0.1	84.2
Latvia	LV	74.7	0.2	0.25	0.99	0.1	0.1	84.2
Estonia	EE	90	0.2	0.25	0.99	0.1	0.1	84.3
Cyprus	CY	85.7	0.2	0.25	0.99	0.1	0.1	84.1
Iceland	IS	58.4	0.1	0.25	0.99	0.1	0.1	84.4
Malta	MT	90	0.1	0.25	0.99	0.1	0.1	84.1

Table 5: Calibration outcomes

D.3 Non-symmetric world economy calibration

Table 5 displays our calibration outcomes.

D.4 Solution method for non-symmetric 26-country model

In principle, computation here should be very difficult: we have a 26 country model, with a separate wealth distribution in each country. However, we observe that countries only interact through the two aggregates (C_t^*, i_t^*). This makes it feasible to solve the model to first order very efficiently by adapting the ideas developed in Auclert et al. (2021a).

Briefly, the idea is to first calculate separately and once and for all, in each country k, sequence-space Jacobians $J^{A,C^*,k}$ and $J^{A,i^*,k}$ as well as $J^{Q,C^*,k}$ and $J^{Q,i^*,k}$ of asset demand A and the real exchange rate Q to the world aggregates C^*, i^*. We can then aggregate these

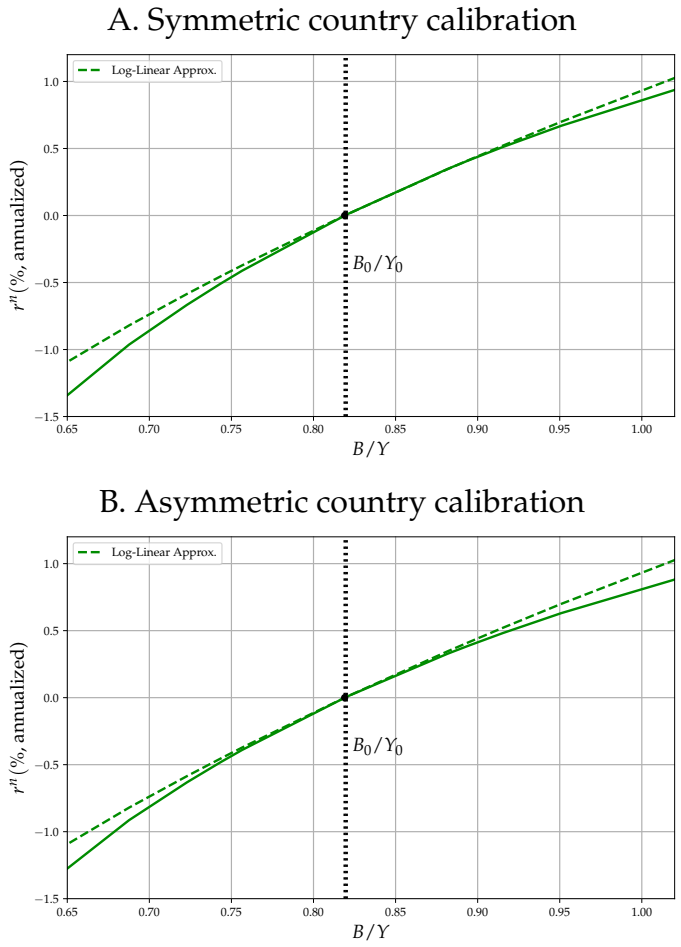


Figure 26: Effect on interest rates vs approximation

Jacobians into a world Jacobian using, for instance, $J^{A,C^*} = \sum \omega^k J^{A,C^*,k}$. Second, we calculate the change in net asset supply $d\boldsymbol{B}^{k,0} - d\mathbf{A}^{k,0}$ and the real exchange rate $d\mathbf{Q}^{k,0}$ that results from the fiscal shock specific to country k. Finally, we differentiate the two equations, (37) and (38), through which countries interact. This gives us a simple linear system in $2T$ unknowns, where T is the truncation horizon of the sequence-space Jacobians:

$$\begin{aligned} J^{Q,C^*} d\boldsymbol{C}^* + J^{Q,i^*} d\boldsymbol{i}^* &= -\sum \frac{\omega^k}{1-\alpha^k} d\mathbf{Q}^{k,0} \\ J^{A,C^*} d\boldsymbol{C}^* + J^{A,i^*} d\boldsymbol{i}^* &= \sum_k \left(d\boldsymbol{B}^{k,0} - d\mathbf{A}^{k,0} \right) \end{aligned}$$

Inverting this system delivers the first-order solution for $(d\boldsymbol{C}^*, d\boldsymbol{i}^*)$. This type of procedure is helpful to solve any time multiple groups of heterogeneous agents interact via a limited set of aggregates.