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EU sanctions on Russia and implications for a small open economy: The case of Cyprus *

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Abstract

This paper aims at assessing quantitatively the macroeconomic impact of EU sanctions against Russia for the economy of Cyprus. To this end, we use a medium-scale micro-founded DSGE model of a small open economy participating in a currency union like the euro area calibrated to the economy of Cyprus. The model features two sectors of production, namely the tradable and the non-tradable one. In this model, EU sanctions influence the sanctioning economy (i.e. Cyprus) through a mix of foreign shocks that hit in principle the tradable sector. In particular, to mimic the economic environment (namely, how all this started in 2022), we analyze first the effects of an energy-type shock modeled as a standard cost-push shock on imported goods. In turn, we add to this economic environment the impact of policy reactions like EU sanctions against Russia. In this context and given the strong trade ties of Cyprus with Russia we model sanctions as two simultaneous negative exogenous shocks, that is, a temporary decrease in the exported goods reflecting primarily reductions observed in tourism and financial services, and inward foreign direct investment (FDI). Contrary to the mild impacts reported in the literature for the majority of EU countries we find non negligible adverse effects for the economy of Cyprus which range from -1.28% to -3.36% in terms of average output loss in the short run. Given Cyprus's vulnerable external position we show that the impact of sanctions depend crucially on the degree of tightening financing conditions which are likely to hit particularly more countries with high initial current account deficits and debt stocks.

Keywords: Cyprus, economic sanctions, trade disintegration

JEL classification: F16, F51

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1 Introduction

The invasion of Russia on February 2022 in Ukraine increased uncertainty and introduced new challenges on the global economic outlook. In this environment, most EU countries were primarily affected by the sharp increase in energy prices that skyrocketed at the time of the invasion. At the same time, EU collectively responded to the Russian military aggression by adopting a set of economic sanctions with the aim of weakening Russia's economic base, depriving it of critical technologies and markets. This did not come without cost for the sanctioning economies as different EU countries were affected to different degrees by sanctions.

Among EU Member States however, Cyprus reflects a unique case, since from the early 2000s developed and maintained until very recently strong financial and trade ties with Russia (see section 2 below). In this regard, Cyprus is highly exposed to the fallout from the war, through direct adverse shocks in its balance of payments accounts (the trade balance and the financial account) and indirect ones through inflationary pressures and international economic linkages.

In this context, this paper aims to quantitatively assess the macroeconomic impact of EU sanctions against Russia for the economy of Cyprus. Specifically, we build a medium-scale micro-founded DSGE model of a small open economy participating in a currency union like the euro area calibrated to the economy of Cyprus. The model features two sectors of production, namely the tradable and the non-tradable one. In this model EU sanctions influence the sanctioning economy (i.e. Cyprus) through a mix of foreign shocks that hit in principle the tradable sector. In particular, to mimic the economic environment (namely, how all this started in 2022), we analyze first the effects of an energy-type shock modeled as a standard cost-push shock on imported goods. In turn, we add to this economic environment the impact of policy reactions like EU sanctions against Russia. In this context and given the trade ties of Cyprus with Russia we model sanctions as two negative exogenous shocks, that is, a temporary decrease in the exported goods (reflecting primarily reductions observed in tourism and financial services), and inward foreign direct investment (FDI).

To examine the robustness and sensitivity of our results we extend our baseline model and incorporate a simple financial constraint as done in several previous studies, e.g. Mendoza (2002), Uribe and Schmitt-Grohé (2017), Dimakopoulou (2021). This constraint means that domestic agents cannot borrow more than a fraction of their assets from the world capital market so that, when it binds, it is like having a sudden stop. We justify this modelling extension based on theoretical and policy grounds. First as is known a collateral constraint can amplify the contraction in aggregate demand in response to a large negative output shock (see Mendoza, 2010, Uribe and Schmitt-Grohé, 2017, Chapter 12) because agents cannot smooth consumption. Second as discussed in Villalvazo (2024), shocks in foreign direct investment flows affect the borrowing capacity because more (less) foreign capital loosens (tightens) the borrowing constraint of the domestic economy. Thus, under such frictions FDI shocks could also amplify the final effect on the economy. On the policy front the inclusion of financial constraints in justified based on a set of macroeconomic indicators in which Cyprus still ranks poorly. In particular, in 2022, measures such as the current account balance, net international investment position, private sector debt and the share of non performing loans were all below the thresholds set by the Macroeconomic Imbalances Procedure of the European Commission.[1] Continued economic and geopolitical shocks such as EU sanctions against Russia and the Middle East conflict, coupled with global monetary tightening, could result in more stringent external borrowing limitations. In this regard nations like Cyprus with considerable current account deficits and notable negative Net International Investment Positions (NIIPs) and private sector debt, might face heightened external borrowing restrictions.

Our main results are as follows. On aggregate, our baseline model indicates an average overall reduction in output of about -1.28% in the short term, that is for a 5 year average period, from 2022 to 2026. Starting from the effects of imported goods inflation, imported goods utilized in the production

[1] See European Commission (2024), Alert Mechanism Report 2024

process constitute a significant portion of total imports in Cyprus. Consequently, as import prices rise due to inflationary pressure from the war, leading to increased input costs, firms are likely to transfer some of these costs to output prices. This inflationary hike slices output by roughly 0.24% during the same period. The most substantial impact though stems from the subsequent policy reaction (EU sanctions) in the form of a temporary decrease in exported services to Russia, resulting in approximately a 1% loss in output. A reduction in inward FDI yields milder effects milder nature, of just 0.12% output loss. The results in the extended model with financial constraints although similar qualitatively, differ markedly in quantitative terms. The total impact on output is more than doubled reaching a 5-year average, post war, of -3.36%. This is again driven by the substantial negative influence of the drop in exports. Additionally, when financial constraints are present, the negative effects from the decrease in inward FDI from Russia are roughly 5 times higher compared to the baseline model. Evidently, financial constraints amplify the effects of such shocks and even more so in the case of inward FDI.

Finally, in a counterfactual experiment we examine how tightening financial conditions could exacerbate economic vulnerability, especially in the face of external shocks like EU sanctions against Russia. To this end we examine how initial household indebtedness affects outcomes, comparing the baseline scenaria, but this time in a counterfactual situation where initial foreign private debt is substantially lower. We show that a lower initial debt level leads to milder recessionary effects, with a roughly 14% reduction compared to higher debt scenarios. This is due to lower interest rates and increased capital inflow, mitigating the overall output decline.

Related academic and policy literature The Russian-Ukraine war and the subsequent EU sanctions have brought again to the spotlight the discussion about the economic impact on both the sanctioned and sanctioning countries ((Hufbauer and Jung, 2020), (Crozet and Hinz, 2020), (Garicano *et al.*, 2022)) and their effectiveness as a response to terrorism, military conflicts, and other foreign policy crises. On the one hand, research suggests that sanctions have lost their potential as a foreign economic policy tool (Felbermayr *et al.*, 2021), nevertheless they exert negative impact at the firm level, even though exporting firms employ sanction avoidance practices through exports in neighboring countries. At the same time, the EU is faced with growing skepticism about sanctions' effectiveness and 'sanctions fatigue' in the sense that the burden of implementation is not equally shared among member countries. Chowdhry *et al.* (2024) report that there exists a critical geographical and sociocultural dimension in the distribution of the sanctions' burden measured in terms of welfare gain/losses. This is particularly relevant for countries sharing geographic proximity and historical ties with Russia, as well as hosting significant Russian speaking populations who face higher costs when implementing sanctions.

From a macroeconomic perspective, our paper is closer to a set of recent studies on the effects of reducing energy imports from Russia, as in e.g. Bachmann *et al.* (2022), who use the multi-sector trade model of Baqaee and Farhi (2020) to estimate the impact of a sudden stop of imported Russian gas to the German economy and estimate a reduction in GDP of 0.2–3.0%. Similarly, Baqaee *et al.* (2022) quantified impacts for selected EU countries with traditional economic ties with Russia, estimating GDP drops between 1–5% (e.g. Lithuania, -5.2%; Bulgaria, -2.7%; Slovakia, -2.7%; Finland,-0.9%; or the Czech Republic, 0.8%). For the rest of the european countries the effects are found to be negligible, that is less than of 0.6% reduction in GDP, including Cyprus. All of these studies however consider sanctions as a type of energy import ban from Russia and the differences in the impact across countries stem from differences in the exposure to Russian imports. However this is not a representative scenario for the case of Cyprus. Instead, our analysis views sanctions as a mix of foreign shocks operating through different channels. Finally, Almazán-Gómez *et al.* (2023), use a multi-regional and multi-sectoral Input-Output table (specifically the EUREGIO-2017), report that sanctions entail the worst outcome for the economy of Cyprus among all European countries, around a 6% reduction in output. Similarly Imbs and Pauwels (2023) assume a ban on European exports to Russia and the fact that trade policy falls under the remit of the European Commission, they consider a blanket embargo in which all member countries stop exporting to Russia including Cyprus. They report a -2.14% fall in Cyprus's GDP which is at least double in magnitude across EU and even higher than ex-satellite countries geographically close to Russia such as Lithuania (-0.93%), Estonia (-0.83%), Latvia (-0.80%), Bulgaria (-0.71%), Finland (-0.61%), Slovenia (-0.53%), Slovakia (-0.52%) or the Czech Republic (-0.50%). In contrast to our approach, the latter papers being based on input-output tables, do not consider potential general equilibrium effects and in particular effects on the balance of payments accounts which are of particular importance for the economy of Cyprus. As showed by our results, the external position of a country amplifies the effects stemming from adverse foreign shocks such as sanctions.

The rest of the paper is organised as follows. Section 3 describes the model employed while section 4 discusses briefly data sources employed, calibration and the initial steady state solution. Section 5 presents the policy experiments, section 6 discusses the simulation results and section 7 discusses further counterfactual experiments and sensitivity experiments. Finally, Section 8 closes the paper with a discussion on policy implications.

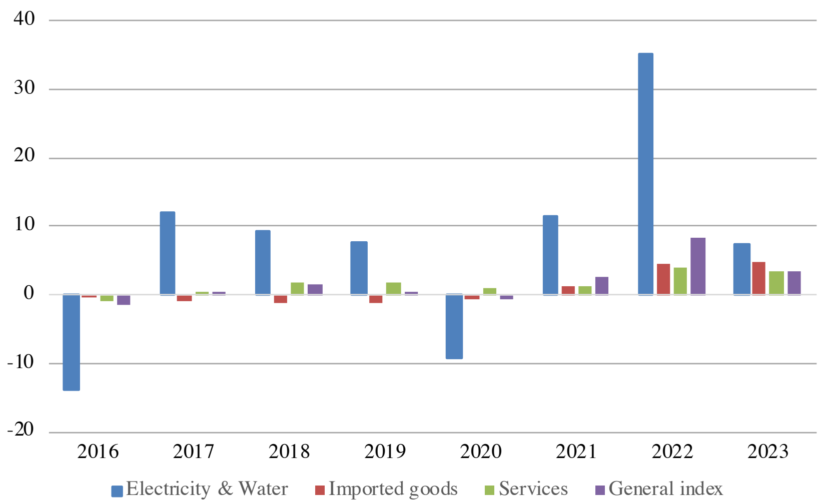
2 Cyprus dependency on Russia and EU's policy reaction

In this section we provide representative data evidence on Cyprus's dependency on Russia and the subsequent policy reaction, namely sanctions, as mirrrored in the balance of payments accounts of Cyprus.

2.1 The economy before the war

Even before the Russian invasion, global inflation was on a rising trend, which is attributed to the simultaneous recovery of post-COVID demand and supply side disruptions, as illustrated in Figure 1. The energy shock due to invasion came to aggravate these inflationary pressures. Although Cyprus does not rely on gas for energy, avoiding the Russian gas dependence observed in other EU countries, it heavily depends on imported oil for electricity, posing a strategic vulnerability. This exposes the Cypriot economy to global oil price fluctuations and high electricity costs, particularly affecting business activity as well as commodity and production input prices. Following the pattern observed across the euro area economies, inflation on imported goods in Cyprus was around 4.6%, contributing to the general inflation of 8.4% in 2022. While the general price index fell below 4% in 2023 due to the reduction in electricity prices, imported goods inflation seems to persist.

Figure 1: Price indexes evolution (y-o-y, %), 2016-2023



Source: Central Bank of Cyprus

2.2 The economy after the war and the policy reaction

Starting from February 2022 the EU has imposed a set of restrictive measures covering a wide range of economic activities.[2] These measures include: restrictions on oil imports/transport, financial and business services measures and prohibitions on the export/import of various goods.[3] Indeed some of these goods and services categories are traditionally at the core of the transactions between Cyprus and Russia. In what follows, based on available data, we briefly illustrate the recent evolution of the main current account items that according to our understanding, sanctions work through. In turn, in the following sections we assess their impact using our calibrated model.

Exports of services Cyprus is mainly a services based economy. This is shown in Table 1 where we present the volume of trade in goods and services as a share of GDP of Cyprus with the rest of the world (panel A) and Russia (panel B). Exports of services constitute more than 60% of its GDP, reaching almost 80% in 2022. A significant portion (more 10% as a share of GDP) is related to Russia even if financial linkages to Russia have been reduced since the financial crisis, exposures through trade in services —mainly tourism and professional services such as accounting, auditing, bookkeeping and tax consulting services, business/management consulting and public relations services, IT consultancy, legal advice, as well as architecture and engineering services — are still high. In 2019 they accounted for more than 80% of the services exports to Russia. By the start of the Russia-Ukraine war in 2022, Cyprus's trade with Russia in terms of services exports nearly halved, from 8.3% to 4.3% as as share of GDP and will likely shrink even more by 2023 and 2024. This outcome stemmed from a notable decline in the export of financial travel services (such as tourism) due to EU sanctions against Russia. However, it's worth noting that, as illustrated in panel A of Table 1, there was an increase in travel services exports to the rest of the world from 7.15% in 2021 to 9.85% in 2022 as a share of GDP. This suggests that Cyprus, at least, redirected its export focus to other markets, partially offsetting the losses incurred from sanctions on Russia.

Table 1: Trade in goods and services of Cyprus

A. Exports - Imports (Cyprus with the rest of the world, % of GDP)

	2019		2020		2021		2022	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Goods	13.29	33.27	13.44	32.51	14.82	32.46	16.49	38.00
Services: Total	63.20	42.19	67.24	49.54	74.60	52.99	78.54	56.72
Financial	16.88	10.36	22.53	14.45	20.58	11.40	18.88	11.41
Travel	12.56	6.31	2.89	2.99	7.15	3.00	9.85	4.66
Transport	14.93	9.76	14.67	8.52	14.91	9.12	14.23	9.70

B. Exports - Imports (Cyprus with Russia, % of GDP)

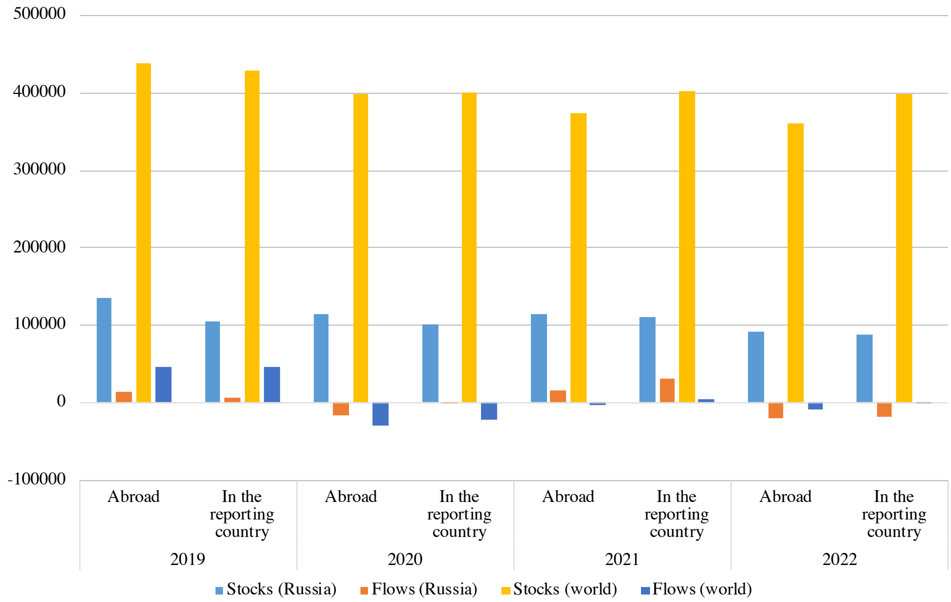
	2019		2020		2021		2022	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
Goods	0.17	0.27	0.64	0.15	0.68	0.32	0.33	0.57
Services: Total	11.11	1.44	10.15	1.47	8.33	1.38	4.36	1.05
Financial	5.52	0.21	6.22	0.35	3.89	0.38	2.55	0.25
Travel	2.37	0.36	0.33	0.14	1.76	0.05	0.24	0.06
Transport	1.62	0.41	1.66	0.41	1.45	0.46	1.09	0.38

Source: Central Bank of Cyprus and authors' calculations

[2] https://finance.ec.europa.eu/eu-and-world/sanctions-restrictive-measures/sanctions-adopted-following-russias-military-aggression-against-ukraine_en

[3] The list is long including goods such luxury, minerals, coal, gold, goods contributing to the enhancement of Russian industrial capacities, quantum computing, advanced semiconductors, sensitive machinery, transportation and chemicals, cement, rubber products, wood, spirits, liquor, high-end seafood.

Figure 2: Foreign Direct Investments, Stocks and Transaction, (2019-2022), mln of euro



Note: Inward direct investment is investment by a non- resident direct investor in a direct investment enterprise resident in the host economy; the direction of the influence by the direct investor is "inward" for the reporting economy. Also referred to as direct investment in the reporting economy.
Source: Central Bank of Cyprus

Foreign Direct Investment Russian Federation ranks first in terms of Cyprus's inward and outward FDI.[4] Cyprus's direct investment ties with Russia (Rest of the world) comprise of assets and liabilities (i.e. FDI stock) equivalent to approximately 400% (1500%) of GDP from 2019 to 2022, stemming primarily from historical practices of channeling capital to capitalize on Cyprus's favorable tax treatment. Similarly with the trade activities, FDI stocks and transactions of Russia with Cyprus accounted for one fourth of the total FDI activity. Note however, that the high level of FDI stock from Russia reduces to around 50% (or 150% from the Rest of the world) of the GDP if Special Purpose Entities (SPEs) are excluded, which accounts for more than 85% of the FDI activity of Cyprus.[5]Similarly, net inward FDI flows from Russia and the rest of the world account roughly for the 18% and 30% respectively (or 3% and 5% respectively, excluding SPEs). However, preceding the conflict, there was a notable reduction in assets held in Russia, leading to a decline in the overall net position. This period coincided with the reinforcement of existing sanctions and the renegotiation of the bilateral double taxation treaty in 2020, diminishing Cyprus's attractiveness as a lucrative hub for Russian businesses. Consequently, there was a significant contraction in inward and outward FDI transactions following the invasion. This is all summarized in Figure 2 where it is clear that 2022 has been a disinvestment year for Cyprus in terms of Russian FDI as a result of sanctions.

3 The baseline model

This section describes the building blocks of our micro-founded dynamic general model constructed to assess the impact on the economy of Cyprus of EU sanctions on Russia. We start with an informal description, then we present the theoretical structure. Further technical details are presented separately in Appendix B.

[4]See United Nations Conference on Trade and Development (UNCTAD) (2023)

[5]The presence of SPEs (i.e. the treatment of SPEs as residents. See Cyprus: 2022 Article IV Consultation-Press Release; Staff Report; Country Report No. 2023/192) in FDI statistics distorts the picture. This is because their transactions and positions are entirely cross-border and do not have any impact on the real economy.

3.1 Modelling stylized facts of the Cypriot economy

We use a fully-fledged medium scale micro-founded dynamic general equilibrium in a small open economy setup belonging to a currency union like the euro area (in the sense that the nominal exchange rate is exogenous and there is no monetary policy independence). Our model incorporates a number of nominal and real frictions and financial market imperfections in the form of financially constrained households and sovereign risk-premia on public debt.

In order to mimic, as good as possible, the production structure of the Cypriot economy, we model private production through a tradable (which mostly accounts for financial services and tourism related services) and a non-tradable goods sector. This is a key structural characteristic of Cyprus's economy. Next, we pay particular attention on modelling the external position of Cyprus. Cypriot public debt is being held by three different types of creditors: domestic private agents/banks, foreign private agents/banks, and EU public institutions. The latter refers to loans from the ESM and other euro states during the sovereign debt crisis and loans from the Recovery Fund during the pandemic (see Dimakopoulou *et al.*, 2022). Notice that, by the end of 2019 namely, just before the eruption of the pandemic crisis, around 60% of Cypriot public debt was owned by foreign entities. Moreover the foreign debt as share of GDP in Cyprus, is about 120% of the GDP , while the current account deficit is systematically high at around 9% (excluding SPEs) as reported in European Commission (2024). Our model attempts to embed the above facts in a sound way.

3.2 Households

The population of the economy consists of households distributed along the range of 0 to 1, with a proportion of ν being identified as Ricardians and the remaining fraction of $1-\nu$ as non-Ricardian households. Ricardians are denoted with the superscript R, while non-Ricardians are denoted with NR. The first type, Ricardian households, has access to financial and capital markets and can transfer wealth inter-temporally by trading bonds and accumulating physical capital, whereas the second type of households, non-Ricardian households, is assumed to be liquidity constrained in the sense that it cannot lend or borrow from domestic and international markets. Both types of households receive labor income by working in the tradable and non-tradable sector.

3.3 Ricardian households

Each Ricardian household, $j \in [0,\nu]$, maximizes its expected discounted lifetime utility in any given period t :

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\ln \left(C_t'^R(j) - bC_{t-1}'^R \right) - \int_0^1 \frac{\left(L_t^R(j,l)\right)^{1+\kappa}}{1+\kappa} dl \right) \tag{1}$$

where $\beta \in (0,1)$ is the discount rate. $C_t'^R(j) \equiv C_t^R(j) + \theta^G G_t^C$ denotes composite consumption comprising of consumption of private final good, $C_t^R(j)$, and consumption of public good, G_t^C. $\theta^G > (<) 0$, measures the degree of substitutability (complementarity) between public and private consumption. The term $bC_{t-1}'^R$ is lagged composite consumption and captures external habit formation, where $b \in [0,1)$. Each Ricardian household, j, supplies a continuum of differentiated labour inputs, $L_t^R(j,l)$, $l \in [0,1]$. The corresponding aggregate quantity of these labour service is $L_t^R(j) \equiv \int_0^1 L_t^R(j,l)\, dl$. The nominal flow budget constraint for Ricardian household, j, in period t is given by:

$$
\begin{aligned}
& P_t\left[\left(1+\tau_t^C\right) C_t^R(j)+I_t^H(j)+I_t^{NT}(j)\right]+B_t(j)+\frac{S_t F_t(j)}{\Phi(\cdot)} \\
= & \left(1-\tau_t^L\right) W_t L_t^R(j)+R_{t-1} B_{t-1}(j)+S_t R_{t-1}^* F_{t-1}(j)+P_t Z_t^R(j)+\Pi_t(j) \\
& +\left(1-\tau_t^K\right) P_t\left(r_t^{k,H} u_t^H(j) \bar{K}_{t-1}^H(j)+r_t^{k,NT} u_t^{NT}(j) \bar{K}_{t-1}^{NT}(j)\right)-P_t\left(\Psi\left(u_t^H(j)\right) \bar{K}_{t-1}^H(j)+\Psi\left(u_t^{NT}(j)\right) \bar{K}_{t-1}^{NT}(j)\right)
\end{aligned} \tag{2}
$$

where P_t is the nominal price of the final good. W_t is the aggregate nominal wage received by the household j. There are two broad kinds of assets: the long-term government bonds and capital.[6]

The term B_t is the real value of $j's$ end- of-period domestic government bonds and F_t denotes the real value of $j's$ end-of-period internationally traded assets denominated in foreign currency (if negative, it denotes liabilities). S_t is the nominal exchange rate expressed as the domestic currency price of one unit of foreign currency. $R_{t-1} \geq 1$ denotes the gross nominal return to domestic government bonds between $t-1$ and t; $R_{t-1}^* \geq 1$ denotes the gross nominal return to international assets between $t-1$ and t; $Z_t^R(j)$ denotes real lump-sum taxes to each household (if negative, it denotes lump-sum transfers).

Ricardian households face a cost of participating in the foreign assets market. The cost function, $\Phi(\cdot)$, depends on the aggregate level of external debt that individual household takes as given (Schmitt-Grohé and Uribe, 2003).[7]

Ricardian households also have access to the capital markets across both sectors of economic activity, traded and non-traded goods sectors. We distinguish variables associated with the traded and non-traded sectors by superscripts $s = H, NT$, respectively. The real rental rates of capital are represented by r_t^k, while dividends are denoted by Π_t. We define effective capital as the product of the utilization rate of capital, u_t and the capital stock, $\bar{K}_{t-1}$. The term $\Psi(u_t)$ denotes the cost of altering the utilization rate of physical capital per unit of capital whereas in the steady-state, this utilization rate is equal to 1, and the associated cost $\Psi(1) = 0$ is zero. The dynamics of physical capital in the traded and non-traded sectors follow Christiano *et al.* (2005):

$$
\bar{K}_t^s(j)=(1-\delta) \bar{K}_{t-1}^s(j)+\left[1-\Gamma\left(\frac{I_t^s(j)}{I_{t-1}^s(j)}\right)\right] I_t^s(j) \tag{3}
$$

where δ denotes the rate of depreciation and the adjustment cost functions for investment, $\Gamma(\cdot)$, is an increasing and convex function (i.e. $\Gamma' > 0$). Furthermore, in the steady-state $\overline{\Gamma} = \overline{\Gamma}' = 0$ and $\overline{\Gamma}'' > 0$. τ_t^C, τ_t^L and τ_t^K are tax rates on consumption, labour income and capital income. The investment adjustment cost function takes the following form:

$$
\Gamma\left(\frac{I_t^s(j)}{I_{t-1}^s(j)}\right)=\frac{v}{2}\left[\frac{I_t^s(j)}{I_{t-1}^s(j)}-1\right]^2
$$

As regards the provision of effective capital services, varying the intensity of utilising the physical capital stock, u^H and u^{NT} is subject to a proportional cost of the form $\Psi(u_t) = \psi_1(u_t - 1) + \frac{\psi_2}{2}(u_t - 1)^2$.

Foreign Direct Investment We incorporate inward foreign direct investment flows into our model following Acosta *et al.* (2009) and Clancy and Merola (2016), by assuming that total investment in the tradable sector I_t^H is a composite of both domestic investment $I_t^{H,H}$ and and exogenous foreign direct

[6]Since Ricardian households are the only owners of these assets, we suppress the superscript R on assets.

[7]The cost function, $\Phi(\cdot)$, is given by the following expression: $\Phi(\cdot) = \left[1 + \psi\left(e^{(a_t - \bar{a})} - 1\right)\right]$, where $a_t \equiv \frac{S_t P_t^* F_t^G - S_t P_t^* F_t}{P_t Y^{GDP}}$ is expressed as the net foreign asset position to GDP ratio. $S_t P_t^* F_t^G$ is debt issued by the Cypriot government, expressed in domestic currency, held by foreigners. In the steady-state, it is assumed that $\Phi(0) = 1$.

investment (from Russia) component $I_t^{H,F}$, which are combined using a standard CES function:

$$I_t^H = \left[(\omega^F)^{\frac{1}{\alpha^F}} (I_t^{H,H})^{\frac{\alpha^F-1}{\alpha^F}} + (1-\omega^F)^{\frac{1}{\alpha^F}} \left(I_t^{H,F} \right)^{\frac{\alpha^F-1}{\alpha^F}} \right]^{\frac{\alpha^F}{\alpha^F-1}} \tag{4}$$

where ω^F denotes the share of domestic investment and α^F the elasticity of substitution between domestic and foreign investment. Foreign direct investment $I_t^{H,F}$ evolves according to:

$$I_t^{H,F} = s_t^{FDI} Y_t^{GDP} \tag{5}$$

where s_t^{FDI} is the net inward foreign direct investment-to-output ratio, which is exogenously determined, and Y_t^{GDP} is the gross domestic product of Cyprus' economy. Note that since this is an exogenous flow transfer from abroad, it must also appear in the balance of payments.

3.4 Non-Ricardian households

Non-Ricardian households share the same preferences as Ricardian households, but they do not determine their wage rates themselves. Instead, they use a rule-of-thumb to set their wage rates based on the average wage rates chosen by Ricardian households. Non-Ricardian households work the same number of hours as the average Ricardian household since they face the same labor demand function. They earn income by working in the tradable and the non-tradable sectors, but they lack access to capital and financial markets, which means they live hand-to-mouth. They consume their after-tax labor income and targeted government lump-sum transfers, Z_t^{NR}. The nominal flow budget constraint for a non-Ricardian household, $j \in (\nu, 1)$ is:

$$\left(1+\tau_t^C\right) P_t C_t^{NR}(j) = \left(1-\tau_t^L\right) W_t L_t^{NR}(j) + P_t Z_t^{NR}(j) \tag{6}$$

3.5 Wage setting and labour aggregation

As regards the labor market in the private sector, households supply differentiated labour services. Only Ricardian households act as wage setters in imperfectly competitive markets. Non-Ricardian households use a rule-of-thumb to set their wage rates based on the average wage rates chosen by the Ricardian households. Each differentiated labour service is supplied by both the Ricardian and non-Ricardian households, and demand is uniformly allocated among households. A perfectly competitive labour agency aggregates the differentiated labour services into a composite labour input, L_t, according to

$$L_t = \left(\int_0^1 L_t(l)^{\frac{\varepsilon^W-1}{\varepsilon^W}} \right)^{\frac{\varepsilon^W}{\varepsilon^W-1}} \tag{7}$$

where $\varepsilon^W \geq 0$ is the steady-state wage markup. The labour packer takes each labour type's nominal wage rate $W_t(l)$ as given. Solving the profit maximisation problem of the labour packer yields the demand function for labour type l :

$$L_t(l) = \left(\frac{W_t(l)}{W_t} \right)^{-\varepsilon^W} L_t \tag{8}$$

where L_t is the demand for composite labour services, and W_t is the aggregate nominal wage.

From this we can derive an aggregate wage index by defining:

$$W_t = \left[\int_0^1 (W_t(l))^{1-\varepsilon^w} dl \right]^{\frac{1}{1-\varepsilon^w}} \tag{9}$$

Staggered wages We assume that the Ricardian household sets wages for the type l labour in a staggered way facing Calvo-type nominal rigidities. Wages get reset with the probability $1-\theta^{w}$ in each period t, while with the complementary probability, θ^{w} wages are set to their previous period level adjusted by the past inflation, $\pi_{t-1}=\frac{P_{t-1}}{P_{t-2}}$ and steady-state inflation π:

$$W_t\left(l\right)=\left(\pi_{t-1}\right)^{\lambda^W}\left(\pi\right)^{1-\lambda^W}W_{t-1}\left(l\right) \tag{10}$$

where λ^W is the degree of wage indexation.[8] When $\lambda^W=1$ there is no indexation and the wages that can not be reoptimized remain constant. When $\lambda^W=0$ there is perfect indexation to past inflation. In turn, when choosing $W_t(l)$, households will discount the future not just by β^k but by $\theta^{w,k}$ as well, since the latter is the probability that a household will be stuck with that wage in period $t+k$. Each union (l) that receives permission to optimally reset its wage rate in period t is assumed to maximise household lifetime utility, as represented by equation (1), taking into account the wage scheme in (10) and the demand for labour services of variety (l). The resulting first-order condition for the union's optimal wage-setting:

$$W_t^{*,\varepsilon^w\kappa+1}=\varepsilon^L\frac{\varepsilon^w}{\varepsilon^w-1}\frac{\mathbb{E}_t\sum\limits_{k=0}^{\infty}\left(\beta\theta^w\right)^k W_{t+k}^{\varepsilon^w(1+\kappa)}\left(\prod\limits_{s=1}^{k}\left(\pi_{t+s-1}\right)\right)^{-\lambda^w\varepsilon^w(1+\kappa)}L_{t+k}^{1+\kappa}}{\mathbb{E}_t\sum\limits_{k=0}^{\infty}\left(\beta\theta^w\right)^k\left(\prod\limits_{s=1}^{k}\left(\pi_{t+s-1}\right)\right)^{-\lambda^w\varepsilon^w}\Lambda_{t+k}L_{t+k}} \tag{11}$$

where W_t^* denotes the optimal wage set by the Ricardian household. Given that all updating households will update to the same wage we can assume that $W_t^*\left(l\right)=W_t^*$ and omit the dependence on the (l) index. the evolution of the aggregate wage is given by:

$$W_t=\left[\left(1-\theta^W\right)\left(\tilde{W}_t\right)^{1-\varepsilon^W}+\theta^W\left(W_{t-1}\left(\pi_{t-1}\right)^{\lambda^W}\left(\pi\right)^{1-\lambda^W}\right)^{1-\varepsilon^W}\right]^{\frac{1}{1-\varepsilon^W}} \tag{12}$$

We allow for imperfect substitutability of labour inputs across different sectors to capture frictions in labour mobility as in Chang *et al.* (2021). The total amount of composite labour is a CES aggregate of the labour used in the tradable, L_t^H, and non-tradable, L_t^{NT} sectors. Thus,

$$L_t=\left[\left(\phi^H\right)^{\frac{1}{\mu^W}}\left(L_t^H\right)^{\frac{\mu^W-1}{\mu^W}}+\left(\phi^{NT}\right)^{\frac{1}{\mu^W}}\left(L_t^{NT}\right)^{\frac{\mu^W-1}{\mu^W}}\right]^{\frac{\mu^W}{\mu^W-1}}$$

where ϕ^H and ϕ^{NT} are the steady-state shares of composite labour worked in the traded and non-traded sectors. μ^W is the elasticity of substitution between sectoral hours worked. Solving the profit maximisation problem yields demand functions of composite labour inputs for the traded and the non-traded sector:

$$L_t^H=\phi^H\left(\frac{W_t^H}{W_t}\right)^{\mu^W}L_t,\quad L_t^{NT}=\phi^{NT}\left(\frac{W_t^{NT}}{W_t}\right)^{\mu^W}L_t \tag{13}$$

and the aggregate wage index (obtained by imposing zero profit conditions):

$$W_t=\left[\phi^H\left(W_t^H\right)^{1+\mu^W}+\phi^{NT}\left(W_t^{NT}\right)^{1+\mu^W}\right]^{\frac{1}{1+\mu^W}} \tag{14}$$

where W_t^H, W_t^{NT} are the nominal wage rates paid in the traded and non-traded sectors, respectively.

[8]It holds that for $k=1,2,3,...$, $W_{t,t+k}\left(l\right)=\left(\pi_{t+k-1}\right)^{\lambda^W}\left(\pi\right)^{1-\lambda^W}W_{t,t+k-1}\left(l\right)$ and $W_{t,t}=W_t^*$

3.6 Firms

Private firms are owned by capital owners. Production is a two-stage process. In the final stage, the final good that is used for private and public consumption and investment is produced. There are two firms namely a final good and a composite tradable good producer. The final good producer uses the composite tradable and the single intermediate non-tradable good to produce the final good. Similarly, the composite tradable good producer utilizes the home produced tradable good and the imported goods to produce the composite tradable good.

In the intermediate stage, the non-tradable and tradable bundles are produced. There is a continuum of intermediate non-tradable firms. Each non- tradable firm indexed by NT hires labour and rents physical capital from households to produce a differianted variety $\mathfrak{v}$: A non-tradable distributor combines all varieties, into an intermediate non-tradable bundle. Similarly, there is a continuum of intermediate home tradable firms, each home tradable firm indexed by H hires labour and rents physical capital from households to produce a differianted variety. A tradable distributor combines all varieties, into an intermediate home tradable bundle.

3.7 Final goods producers

We assume that the final goods are produced in two stages by both wholesale and retail firms. First, a continuum of wholesale firms purchase a composite final tradable goods, Y_t^T, and a composite non-tradable goods, Y_t^{NT}, to produce a differentiated final good $Y_t(i)$ in the unit interval:

$$Y_t(i) = \left[\omega^{\frac{1}{z}}\left(Y_t^T\right)^{\frac{z-1}{z}} + (1-\omega)^{\frac{1}{z}}\left(Y_t^{NT}\right)^{\frac{z-1}{z}}\right]^{\frac{z}{z-1}}, i \in [0,1] \tag{15}$$

where ω denotes the fraction of final tradable goods that are used for the production of the final good, and z denotes the elasticity of substitution between the composite final tradable goods and non-tradable goods. The wholesale firm, i, minimises its cost subject to its production function (15) that yields the demand functions:

$$Y_t^T = \omega\left(\frac{P_t^T}{P_t}\right)^{-z} Y_t(i),\ Y_t^{NT} = (1-\omega)\left(\frac{P_t^{NT}}{P_t}\right)^{-z} Y_t(i) \tag{16}$$

where P_t^T and P_t^{NT} are the price level of tradables and non-tradables, respectively. Thus, from the zero profit condition we can obtain the price index of a unit of the private final good (i.e. the consumer's price index), which is a weighted sum of the price indices of the tradable and non tradable goods intermediate goods:

$$P_t = \left[\omega\left(P_t^T\right)^{1-z} + (1-\omega)\left(P_t^{NT}\right)^{1-z}\right]^{\frac{1}{1-z}} \tag{17}$$

3.8 Composite tradable goods

Final tradable goods production, Y_t^T, is a composite of home produced and foreign intermediate tradable goods

$$Y_t^T = \left[\left(\omega^H\right)^{\frac{1}{z^H}}\left(Y_t^D\right)^{\frac{z^H-1}{z^H}} + \left(1-\omega^H\right)^{\frac{1}{z^H}}\left(\left(1-\Gamma_F(Y_t^F/Y_t^T;\varepsilon_t^F)\right)Y_t^F\right)^{\frac{z^H-1}{z^H}}\right]^{\frac{z^H}{z^H-1}} \tag{18}$$

where Y_t^D, is domestic tradable goods used in the production of composite final tradable goods; z^H and ω^H are the elasticity of substitution between domestically and foreign-produced tradable goods and its share, respectively. $\Gamma_F(Y_t^F/Y_t^T;\varepsilon_t^F)$ is a convex adjustment cost on imported goods, defined as:

$$\Gamma_F(Y_t^F/Y_t^T;\varepsilon_t^F) \equiv \frac{\gamma^F}{2}\left((\varepsilon_t^F)^{-\frac{1}{\gamma^F}}\frac{Y_t^F/Y_{t-1}^F}{Y_t^T/Y_{t-1}^T}-1\right)^2 \tag{19}$$

Y_t^D and Y_t^F are Dixit-Stiglitz aggregators of all intermediate tradable goods produced at home and foreign countries, respectively,

$$Y_t^D = \left[\int_0^1 Y_t^D(h)^{\frac{\epsilon^H-1}{\epsilon^H}}\,dh\right]^{\frac{\epsilon^H}{\epsilon^H-1}},\ \ Y_t^F = \left[\int_0^1 Y_t^F(f)^{\frac{\epsilon^F-1}{\epsilon^F}}\,df\right]^{\frac{\epsilon^F}{\epsilon^F-1}} \tag{20}$$

where ϵ^H is the elasticity of substitution between home-produced intermediate tradable goods, and ϵ^F is the elasticity of substitution for foreign-produced tradables . The producer of composite tradable goods is competitive and maximises profits subject to (18) and (20), respectively. The profit maximisation yields the following input demand functions for the home and foreign-produced intermediate tradable goods:

$$Y_t^D = \omega^H\left(\frac{P_t^H}{P_t^T}\right)^{-z^H} Y_t^T,\ \ Y_t^D(h) = \left(\frac{P_t^H(h)}{P_t^H}\right)^{-\epsilon^H} Y_t^D \tag{21}$$

$$Y_t^F = (1-\omega^H)\left(\frac{P_t^F}{P_t^T\Gamma_F^\dagger(Y_t^F/Y_t^T;\varepsilon_t^F)}\right)^{-\zeta^H}\frac{Y_t^T}{1-\Gamma_F(Y_t^F/Y_t^T;\varepsilon_t^F)},\ \ Y_t^F(f) = \left(\frac{P_t^F(f)}{P_t^F}\right)^{-\epsilon^F} Y_t^F \tag{22}$$

where

$$P_t^H = \left[\int_0^1 P_t^H(h)^{1-\epsilon^H}\,dh\right]^{\frac{1}{1-\epsilon^H}},\ P_t^F = \left[\int_0^1 P_t^F(f)^{1-\epsilon^F}\,df\right]^{\frac{1}{1-\epsilon^F}} \tag{23}$$

and

$$P_t^T = \left[\omega^H\left(P_t^H\right)^{1-z^H} + \left(1-\omega^H\right)\left(\frac{P_t^F}{\Gamma_F^\dagger(Y_t^F/Y_t^T;\varepsilon_t^F)}\right)^{1-z^H}\right]^{\frac{1}{1-z^H}} \tag{24}$$

$$\Gamma_F^\dagger = 1-\Gamma_F(Y_t^F/Y_t^T;\varepsilon_t^F)-\Gamma_F'(Y_t^F/Y_t^T;\varepsilon_t^F)Y_t^F \tag{25}$$

Intermediate tradable goods The continuum of intermediate tradable firms operate in the monopolistically competitive market, producing differentiated goods for domestic consumption, $Y_t^D(h)$ and exports, $Y_t^x(h)$. Thus, the production technology for each good h is:

$$\underbrace{Y_t^D(h)+Y_t^X(h)}_{Y_t^H(h)} = A_t^H\left[K_t^H(h)\right]^{a^H}\left[L_t^H(h)\right]^{1-a^H} \tag{26}$$

where A^H is the total factor productivity in the traded sector. First, each firm h solves a cost minimization problem, by minimizing its cost choosing its factor inputs, in particular physical capital, $K_t^H(h)$ and labour, $L_t^H(h)$ given technology and prices. The solution will give a minimum nominal cost function, which is a function of factor prices and output produced by the firm. In turn, given this cost function, each firm, which is able to reset its price, solves a maximization problem by choosing its price. Firm's h cost function is given by:

$$C\left(Y_t^H(h)\right) = \min_{\{K_t^H(h),L_t^H(h)\}}\{P_t r_t^{k,H} K_{t-1}^H(h) + (1+\tau_t^{PR})W_t^H L_t^H(h)\}$$

taking prices as given and subject to the production function. Each firm has to pay a payroll tax, τ_t^{PR} in addition to the wage. Cost minimisation of intermediate tradable firm yields the nominal marginal cost of production which is not firm-specific:

$$MC_t^H = \frac{\left[(1+\tau_t^{PR})W_t^H\right]^{1-a^H}\left(P_t r_t^{k,H}\right)^{a^H}}{A_t^H\left(a^H\right)^{a^H}\left(1-a^H\right)^{1-a^H}} \tag{27}$$

and the optimal capital-labour ratio:

$$\frac{K_t^H}{L_t^H} = \frac{a^H}{1-a^H}\frac{(1+\tau_t^{PR})W_t^H}{P_t r_t^{k,H}} \tag{28}$$

where $K_t^H = \int_0^1 K_t^H(h)dh$ and $L_t^H = \int_0^1 L_t^H(h)dh$.

Calvo price setting The second stage of the problem of the intermediate firm is defining the price of its goods. This firm decides how much to produce in each period subject to Calvo type nominal rigidities. Thus, the wholesale firm has a probability θ^H of keeping the price of its good fixed in the next period and a $\left(1-\theta^H\right)$ probability of optimally defining its price.[9]. Firms also index their prices to past sectorial inflation (as in Smets and Wouters (2003)) according to the rule:

$$P_t^H(h) = \left(\pi_{t-1}^H\right)^{\lambda^H}\left(\pi^H\right)^{1-\lambda^H} P_{t-1}^H(h) \tag{29}$$

where $\pi_{t-1}^{\{H\}} \equiv \frac{P_{t-1}^{\{H\}}}{P_{t-2}^{\{H\}}}$ is the sectorial inflation rate, π^H is the steady-state sectorial inflation rate, and $\lambda^H \in [0,1]$ is the degree of price indexation determining the weights given to past inflation where $\lambda^H = 0$ denotes no indexation and $\lambda^H = 1$ is total indexation. It is convenient to express the above in recursive form:

$$\tilde{P}_t^H = \frac{\epsilon^H}{\epsilon^H - 1}\frac{p_t^{1,H}}{P_t^{2,H}}. \tag{30}$$

$$p_t^{1,H} = \varepsilon_t^{p,H} mc_t^H\left(Y_{t+k}^{H,d} + Y_t^X\right) + \beta\theta^H\frac{\Lambda_{t+1}}{\Lambda_t}\left(\frac{\pi_{t+1}^H}{\left(\pi_t^H\right)^{\lambda^H}\left(\pi^H\right)^{1-\lambda^H}}\right)^{\epsilon^H}\mathbb{E}_t P_{t+1}^{1,H} \tag{31}$$

$$P_t^{2,H} = p_t^H\left(Y_{t+k}^{H,d} + Y_t^X\right) + \beta\theta^H\frac{\Lambda_{t+1}}{\Lambda_t}\left(\frac{\pi_{t+1}^H}{\left(\pi_t^H\right)^{\lambda^H}\left(\pi^H\right)^{1-\lambda^H}}\right)^{\epsilon^H-1}\mathbb{E}_t P_{t+1}^{2,H} \tag{32}$$

The evolution of the aggregate price index of tradables is:

$$P_t^H = \left\{(1-\theta^H)\left(\tilde{P}_t^H\right)^{1-\epsilon^H} + \theta^H\left[P_{t-1}^H\left(\pi_{t-1}^H\right)^{\lambda^H}\left(\pi^H\right)^{1-\lambda^H}\right]^{1-\epsilon^H}\right\}^{\frac{1}{1-\epsilon^H}} \tag{33}$$

3.9 Non-tradable goods sector

The production of non-tradable goods follows the same structure as the tradables. Detailed presentation of equilibrium conditions is presented separately in the Appendix.

[9]The price of the firm that has not been able to reoptimize for k periods is $P_{t+k}^H = P_t^H \prod_{s=1}^{k}\left(\pi_{t+k-1}^H\right)^{\lambda^H}\left(\pi^H\right)^{1-\lambda^H}$

3.10 Domestic producers

There is a continuum of importing firms, $f \in [0,1]$. The demand function for each differentiated imported good is given by,

$$Y_t^F(f) = \left[\frac{P_t^F(f)}{P_t^F}\right]^{-\epsilon^F} Y_t^F \tag{34}$$

where

$$P_t^F = \left[\int_0^1 P_t^F(f)^{1-\epsilon^F} df\right]^{\frac{1}{1-\epsilon^F}}. \tag{35}$$

Following (Monacelli, 2005), these firms operate under monopolistic competition giving them a small degree of pricing power. This pricing power creates a wedge between the price at which the importing firms purchase the foreign good in the world market, $S_t P_t^{F*}$ and the price to which they sell these goods to domestic households which is given by:

$$gap_t = \frac{S_t P_t^{F*}}{P_t^F} < 1 \tag{36}$$

Note that P_t^F is price 'at the dock' of the imported good F, where perfect pass-through still holds. Imperfect exchange rate pass-through, however, is ensured via nominal rigidities in the imported sector. As discussed in (Coenen *et al.*, 2012) the empirical evidence appears to be in favor of the chosen specification, implying that the degree of pass-through is partial in the short-run but complete in the long-run, as demonstrated, for example, by Campa and Goldberg (2005). which as previously, yields the following optimality conditions:

$$\tilde{P}_t^F = \frac{\epsilon^F}{\epsilon^F - 1}\frac{P_t^{1,F}}{P_t^{2,F}} \tag{37}$$

$$P_t^{1,F} = \varepsilon_t^{p,F} P_t^F Y_t^F + \beta\theta^F \frac{\Lambda_{t+1}}{\Lambda_t}\left(\frac{\pi_{t+1}^F}{\left(\pi_t^F\right)^{\lambda^F}\left(\pi^F\right)^{1-\lambda^F}}\right)^{\epsilon^F} \mathbb{E}_t P_{t+1}^{1,F} \tag{38}$$

$$P_t^{2,F} = P_t^F Y_t^F + \beta\theta^F \frac{\Lambda_{t+1}}{\Lambda_t}\left(\frac{\pi_{t+1}^F}{\left(\pi_t^F\right)^{\lambda^F}\left(\pi^F\right)^{1-\lambda^F}}\right)^{\epsilon^F - 1} \mathbb{E}_t P_{t+1}^{2,F} \tag{39}$$

The evolution of the price level of imported goods is:

$$P_t^F \equiv \left\{(1-\theta^F)\left(\tilde{P}_t^F\right)^{1-\epsilon^F} + \theta^F\left[P_{t-1}^F\left(\pi_{t-1}^F\right)^{\lambda^F}\left(\pi^F\right)^{1-\lambda^F}\right]^{1-\epsilon^F}\right\}^{\frac{1}{1-\epsilon^F}}. \tag{40}$$

3.11 The Government

The government levies taxes on consumption, on income from labour and capital earnings, lump-sum taxes, and issues one-period government bonds in the domestic bond market and the international markets. Total tax revenues plus the issue of new government bonds are used to finance government purchases of goods and services, government transfers allocated to optimizing and liquidity constrained households, and interest payments on public debt. Notice that the interest rates can vary depending on the identity of the creditor. For instance, we assume that when the government borrows from the (domestic and foreign) market, it pays the market interest rate, R, while when the government borrows from the EU or the ES, it pays an exogenous and constant rate, R_t^{EU}. This follows closely Economides *et al.* (2022).

3.11.1 Public revenues and expenditures

Public revenues are composed of aggregate tax revenues REV_t, including transfers coming from the EU; P_tB_t is the debt held by domestic Ricardian households, $S_tP_t^*F_t^G$ is the debt held by foreigners and $S_tP_t^*F_t^{EU}$ is the debt held by Institutions; the sum of all the previous terms is the total long run debt D_t. The expenditure side features the cost of servicing bonds maturing at time t as well as general government consumption, G_t^C and lump sum transfers, Z_t. The government budget constraint in nominal terms reads as:

$$P_tB_t + \frac{S_tP_t^*F_t^G}{\Phi(\cdot)} + S_tP_t^*F_t^{EU} + P_tREV_t = R_{t-1}B_{t-1} + R_{t-1}^*P_t^*S_tF_{t-1}^G + R_t^{EU}S_tP_t^*F_t^{EU} + P_tG_t^C + P_tZ_t \tag{41}$$

Total revenues are defined as:

$$REV_t \equiv \tau_t^C\left[\nu C_t^R + (1-\nu)C_t^{NR}\right] + (\tau_t^L + \tau_t^{PR})\frac{W_t}{P_t}L_t + \tau_t^K\nu\left(r_t^{k,H}u_t^H\bar{K}_{t-1}^H + r_t^{k,NT}u_t^{NT}\bar{K}_{t-1}^{NT}\right) \tag{42}$$

where $L_t = \int_0^1 L_t(j)\,dj = L_t^R = L_t^{NR}$, as the average Ricardian and non-Ricardian households work the same number of hours. One of the policy variables must follow residually to satisfy the budget constraint above. This is done by the end-of-period total public debt, while the spending-tax policy instruments will be set as in the data. We can express the term, D_t as share, i.e. $\lambda_t^{EU} \equiv \frac{S_tP_t^*F_t^{EU}}{P_tD_t}$, $\lambda_t^D \equiv \frac{P_tB_t}{P_tD_t}$, and $\lambda_t^G \equiv \frac{S_tP_t^*F_t^G}{P_tD_t}$ are shares of total public debt held EU public institutions, domestic and foreign households respectively, where the share $0 \leq \lambda_t^D, \lambda_t^{EU}, \lambda_t^G \leq 1$ are exogenously given and $\lambda_t^D = 1 - \lambda_t^{EU} - \lambda_t^G$. Lump-sum transfers are also identical across households, such that, $Z_t = \int_0^1 Z_t(j)\,dj = Z_t^R = Z_t^{NR}$.

3.11.2 Fiscal rules

We follow a rule-like approach to policy. We focus on simple rules, meaning that the fiscal authority reacts to a number of easily observable macroeconomic indicators capturing the current state of the economy. Specifically, we allow one of the main spending–tax policy instruments, $\chi \in \{ G_t^C, Z_t, \tau_t^C, \tau_t^L, \tau_t^K \}$ to react to the ratio of public liabilities to GDP as a deviation from its steady state value. In our benchmark solution this is done by government lump-sum transfers Z_t. The rule has the following form:

$$\frac{\chi_t}{\chi} = \left(\frac{\chi_{t-1}}{\chi}\right)^{\rho^\chi}\left(\frac{s_{t-1}^D}{s^D}\right)^{(1-\rho^\chi)\gamma^\chi}$$

where $s_t^D \equiv \frac{P_tB_t + S_tP_t^*F_t^G + S_tP_t^*F_t^{EU}}{P_tY_t^{GDP}}$ denotes the total public debt to GDP ratio, and s^D is the steady state value. Similarly, $\{G^C, Z\}$ are the steady states of scaled government purchases, and transfers, respectively and ρ^χ are autoregressive coefficients.

3.12 Monetary policy regime

To solve the model, we need to specify the exchange rate regime. Since the model is applied to a country belonging to a currency union, we assume monetary policy independence. In particular, we assume that the nominal exchange rate, S_t, is exogenously set and, at the same time, the domestic nominal interest on domestic government bonds, R_t is an endogenous variable and that the nominal depreciation rate is $\frac{S_t}{S_{t-1}}$.

The household's first-order conditions (A.2) and (A.3) imply that the nominal interest rate on domestic government bonds, R_{t+1}, is driven by fluctuations of the nominal interest rate at which the domestic country borrows from the international capital markets, R_{t+1}^*:

$$\mathbb{E}_t \frac{\Lambda_{t+1}}{\Lambda_t}\left[R_t - R_t^* \frac{S_{t+1}}{S_t}\Phi(\cdot)\right] = 0 \quad (43)$$

The real exchange rate is defined as:

$$R_t^x \equiv \frac{S_t P_t^*}{P_t} \quad (44)$$

where $P_t^* = P_t^{F*}$ is the aggregate foreign price.

3.13 Foreign final good firms and foreign demand

A representative foreign final good firm combines the purchases of the differentiated exported goods, $Y_t^X(h)$ produced by the domestic intermediate good firms, h and transforms them into a homogeneous good and transforms them into a homogeneous final good Y_t^X via the CES technology:

$$Y_t^X = \left[\int_0^1 Y_t^X(h)^{\frac{\epsilon^x-1}{\epsilon^x}} dh\right]^{\frac{\epsilon^x}{\epsilon^x-1}} \quad (45)$$

where the parameter $\epsilon^x = \epsilon^H > 1$ is related to the elasticity of substitution between the differentiated outputs supplied by the domestic intermediate good firms. The foreign firm takes the prices of the exported differentiated goods P_t^X/S_t (in terms of foreign currency) as given and choose the optimal amounts of differentiated inputs to minimize total input costs $\int_0^1 \left(P_t^X/S_t Y_t^X(h)dh\right)$ subject to 45. The demand function from this cost minimization problem is given by:

$$Y_t^X(h) = \left(\frac{P_t^X(h)}{P_t^X}\right)^{\frac{\epsilon^x-1}{\epsilon^x}} Y_t^X \quad (46)$$

where

$$P_t^X = \left[\int_0^1 P_t^X(h)^{1-\epsilon^x} dh\right]^{\frac{1}{1-\epsilon^X}} \quad (47)$$

is the aggregate price index of the exported domestic intermediate goods and Y_t^X is total foreign demand for domestic intermediate goods. In turn we link the foreign output Y_t^* to the Cypriot exports, Y_t^X as in Lorenzoni (2014):

$$Y_t^X = \left(\frac{P_t^X}{S_t P_t^* \Gamma_X^\dagger(Y_t^X/Y_t^*;\varepsilon_t^X)}\right)^{-z^x} \frac{Y_t^*}{1-\Gamma_X(Y_t^X/Y_t^*;\varepsilon_t^X)} \quad (48)$$

where $\Gamma_X(Y_t^X/Y_t^*;\varepsilon_t^X)$ is an adjustment cost associated with changing the composition of exports, defined as:

$$\Gamma_X(Y_t^X/Y_t^*;\varepsilon_t^X) \equiv \frac{\gamma^X}{2}\left((\varepsilon_t^X)^{-\frac{1}{\gamma^X}} \frac{Y_t^X/Y_{t-1}^X}{Y_t^*/Y_{t-1}^*} - 1\right)^2 \quad (49)$$

where:

$$\Gamma_X^\dagger = 1 - \Gamma_X(Y_t^X/Y_t^*;\varepsilon_t^X) - \Gamma_X'(Y_t^X/Y_t^*;\varepsilon_t^X)Y_t^X \quad (50)$$

3.14 Debt elastic interest rate

For convergence to a well defined steady state without non-stationarity problems, we need to depart from the benchmark small open economy model (see Schmitt-Grohé and Uribe, 2003). We therefore endogenize the world interest rate, i.e. the nominal interest rate at which the domestic country borrows from the international capital markets $\tilde{R}_t^*$. We assume that the small open economy risk premium is an increasing function of the end-of-period total public debt as a share of nominal GDP, s_t^D, when this share exceeds an exogenous certain threshold $\mathcal{D}$, meaning that the interest rate at which private agents borrow from abroad is public debt-elastic. The equation governing the sovereign risk premia is:

$$R_t^* = \tilde{R}_t^* + \psi^d \left(e^{s_t^D - \mathcal{D}} - 1 \right) \tag{51}$$

3.15 Closing the model

In order to close the model we impose the market clearing condition for the final good as:

$$Y_t = \nu C_t^R + (1-\nu) C_t^{NR} + \nu I_t^H + \nu I_t^{NT} + \nu \Psi \left(u_t^H \right) \bar{K}_{t-1}^H + \nu \Psi \left(u_t^{NT} \right) \bar{K}_{t-1}^{NT} + G_t^C \tag{52}$$

Evolution of net private assets The evolution of the net foreign private assets is derived from the optimizing households' budget constraint, after imposing the budget constraint of the liquidity constrained households, the government budget constraint, the definition of profits of intermediate goods producers and importing firms, and by making use of the zero profit conditions of the final good firms:

$$S_t P_t^* \left(\frac{\nu F_t - F_t^G - F_t^{EU}}{\Phi(.)} \right) = S_t R_{t-1}^* P_{t-1}^* \left(\frac{\nu F_{t-1} - F_{t-1}^G}{\Phi(\cdot)} \right) - R^{EU} S_t P_t^* F_{t-1}^{EU} + P_t^X Y_t^X - P_t^F Y_t^F + \nu I_t^{H,F} \tag{53}$$

Definition of Gross Domestic Product In accordance with national accounts statistics, the domestic GDP is defined as the private sector production:

$$P_t Y_t^{GDP} \equiv P_t^H Y_t^H + P_t^{NT} Y_t^{NT} \tag{54}$$

3.16 The extended model: adding a simple financial constraint

To the above setup, we add a financial constraint, restricting household's borrowing ability to be a fraction of total capital available. In particular, we follow Bianchi and Mendoza (2020) and Dimakopoulou (2021) so that:

$$S_t F_t \geq -\kappa \left(u_t^H K_t^H + u_t^{NT} K_t^{NT} \right) \tag{55}$$

where $0 < \kappa < 1$ is a parameter determining the fraction of total capital in the economy that households can borrow. The new optimality conditions with respect to international assets and capital in the traded and non-traded sectors are given in Appendix D.

3.17 Macroeconomic equilibrium

The system consists of 66 equations in 66 variables. This is given the paths of the exogenously set variables whose values will be set as in the data and initial values for the state variables. Market-clearing conditions and the full macroeconomic system are respectively presented in Appendices B and C.

4 Calibration, numerical solution and methodology

We calibrate the model to the Cypriot economy at annual frequency. The calibration is supposed to capture the long-term steady-state of the economy during the period 2009-2019. That is we do not take into account the pandemic years that were influenced by a set of COVID-related factors deemed as temporary shocks. In doing so we use data from various sources such as the Eurostat, AMECO, Cyprus Statistical Authority, OECD-TiVA accounts and the World Input-Output database (WIOD). Then we solve the model numerically using a first-order taylor approximation implemented in DYNARE.[10] Details on calibration and data are presented separately in Appendix E.

[10] We report that we have also solved the model under a second-order approximation. Our results are not affected by the approximation order.

4.1 Steady state solution

The stationary solution of the model is displayed in Table 2 for key macroeconomic variables. The solution is in line with data averages of 2009-2019 and can thus provide a reasonable departure for the policies that have been taking place after 2021 and are studied in the next sections. As can be seen, the model does a relatively good job at mimicking the position of the country in the international capital market, as well as the consumption and investment behavior of households.

Table 2: Steady state run solution: model vs data

Variable	Model	Data 2009-2019
Private consumption to GDP ratio	0.60	0.64
Private investment to GDP ratio	0.15	0.18
Trade balance to GDP ratio	0.01	0.00
Net foreign assets to GDP ratio	−1.28	−1.38
Current account to GDP ratio	−0.03	−0.06
Primary deficit to GDP ratio	0.04	0.03
Public debt to GDP ratio	0.83	0.82

Note: The initial steady state solution of the baseline and the financially constrained model is the same. This achieved by calibrating the collateral share parameter value $\kappa = 0.23$, in the financially constrained model, so that the ratio of foreign assets to total capital holdings and net foreign assets to GDP ratio is the same between the two.

5 How we model sanctions

In this section we describe how we model the economic sanctions imposed against Russia by the EU and Cyprus. We first model a no policy scenario (S1) in the sense that transitional dynamics are only driven by the inflationary shocks on imported goods due to war. Next, we model the EU sanctions policy reaction (i.e. sanctions) as a temporary reduction of exports of services (S2) and a temporary reduction of inward FDI from Russia (S3).

5.1 Policy scenaria

Scenario 1 (S1): No policy reaction - Temporary increase in imported goods prices. We assume a temporary cost-push shock, in the imported goods sector that increases the inflation rate of imports by 4.62 pp on impact so as to match the increase in 2022-2023, which coincides with the war period. The temporary cost-push shock follows an AR1 process, whose persistence, $\rho^{\varepsilon^{p,F}}$, is calibrated such that imported goods inflation goes back to its pre-war levels after about 3 years.

$$\log\left(\varepsilon_t^{p,F}\right) = \rho^{\varepsilon^{p,F}} \log\left(\varepsilon_{t-1}^{p,F}\right) + \varepsilon_t^{\varepsilon^{p,F}} \tag{56}$$

Scenario 2 (S2): Policy reaction - Temporary ban of exports to Russia. We assume a temporary reduction in exports. Exports Y_t^* evolve according to an exogenous AR1 process:

$$\log\left(Y_t^*\right) = \rho^{y^*} \log\left(Y_{t-1}^*\right) + \varepsilon_t^{y^*} \tag{57}$$

where $\rho^{y^*} \in (0,1)$ is a parameter measuring the persistence of the shock whose value is calibrated such that exports return to their pre-war levels after about 3 years; $\varepsilon_t^{y^*}$ is chosen so as to match a drop of 1.8% in 2022.[11] When calculating the size of this shock one should bear in mind the following. As discussed in Section 2, the decrease of exports of services (and in particular financial, travel and transport services) to

[11]See also Benczur and Konya (2016) and Lozej *et al.* (2023) for similar experiments.

Russia as a share of GDP has been about 3% post-invasion. In order to be consistent with our calibration methodology we weight the nominal decrease of this metric by 0.6 which is the share of the domestic value added content of Cypriot exports to the Russian Federation according to OECD-TiVA accounts. At the same time this weighting aims to capture potential double counting arising due to global supply chains (see Johnson, 2014).

Scenario 3 (S3): Policy reaction - Temporary reduction in inward FDI. We assume a reduction in inward FDI flows from Russia equal to 6% as a share of GDP so as to roughly capture the decrease in FDI flows observed in 2022. The FDI shock follows an AR1 process, whose persistence, ρ^{FDI}, is chosen such that inward FDI flows return to their pre-war levels after about 3 years.[12]

$$s_t^{FDI} = \rho^{FDI} s_{t-1}^{FDI} + \varepsilon_t^{FDI} \tag{58}$$

6 Results

This section reports the implications for the economy of Cyprus of the adoption of sanctioning measures against Russia. Table 3 summarizes the effects on output for an average five year period under the three scenaria presented in the previous section both for the baseline model and extended with financial frictions model.

Table 3: Impact on output (average 2022-2026)

	S1	S2	S3	Total
Baseline model	−0.24	−0.92	−0.12	−1.28
Model with financial frictions	−0.50	−2.36	−0.50	−3.36

Note: Results are expressed in % deviations from the initial steady state

As perhaps expected, sanctions negatively affect the overall economic activity by causing a total output drop of -1.28%. As shown in Table 3 a positive cost-push shock in imported intermediate goods prices (S1), causes an average -0.24% decrease in output. The adverse effects are enhanced by the subsequent policy reaction. A temporary export demand reduction (S2) leads to an average -0.92% drop in output in the 5 years after imposing sanctions, while a minor impact comes from reduced FDI inflows (S3) from Russia causing a drop in output by -0.12%. In the presence of borrowing constraints our results although similar in qualitatively, they differ markedly in quantitative terms where the impact for each scenario studied is more than doubled reaching a total average negative impact of -3.36%.

Transmission mechanism in the baseline model Figures 3 to 5 illustrate the dynamic paths for selected model variables as deviations from the initial pre-war steady state.

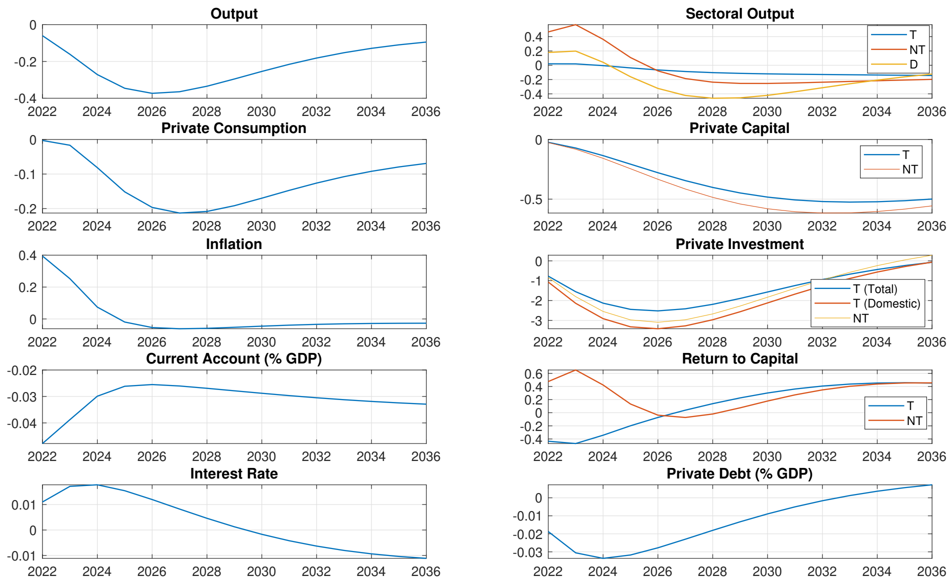
Starting from S1, Figure 3 illustrates the effects of an increase in the prices of imported intermediate goods. The rise in imported goods prices causes a rise in the production costs of tradable goods and this is in turn reflected in the total inflation rate due to pass-through effects to the rest of the production sectors. Intertemporal substitution effects induce an increase in the demand for domestically produced non-tradable goods in the short-run while output in the tradable sector falls (due to reduced demand for domestically produced tradable goods and imported goods). Inflationary pressures induce negative wealth effects reflected in lower private consumption and private investment in the short-run. Finally reduced imports cause an improvement in the trade balance.

[12]Note that the shock duration in S1 is based on the most recent ECB press releases about inflation taming. Regarding S2 and S3, our assumption about the duration of shocks is based on the fact that at the time this paper was written, sanctions against Russian were already in their third year of implementation, therefore we use 3 years as the mimimum possible duration. In a sensitivity check we report results under higher shocks persistence in the Appendix. As expected, longer shocks duration comes with stronger negative impacts for output.

Figure 4 illustrates the dynamic response after an export ban to Russia. We notice that apart from the direct negative effect on exports and output there is an indirect effect on all domestic demand components, including consumption and private investment on both the tradable and non-tradable sector. Moreover the decline in exports and the desire of households to smooth their consumption tends to increase the paths of household borrowing. Lower exports naturally deteriorate trade balance and net foreign assets as a share of GDP.

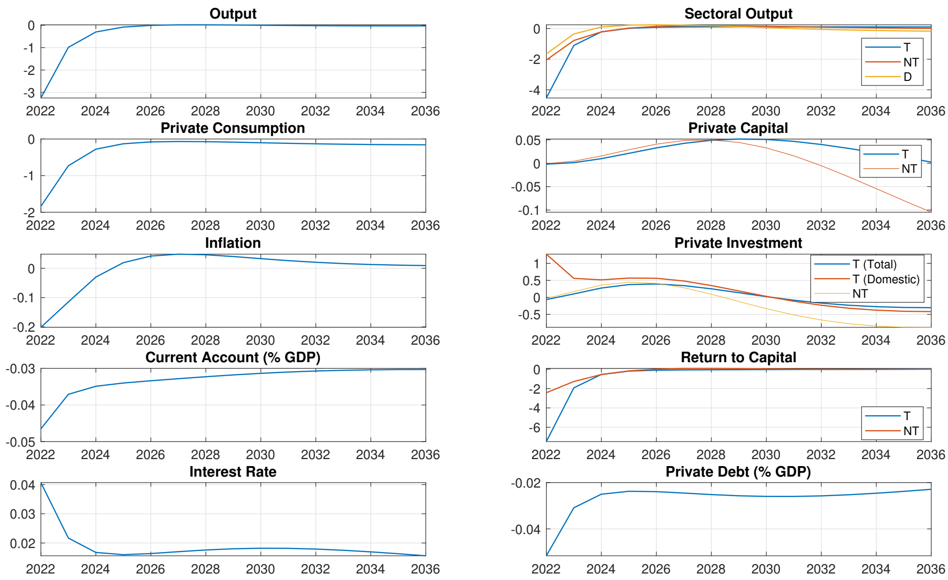
Figure 5 illustrates the effects of a decrease in inward FDI from Russia to Cyprus. By construction, the shock hits predominantly the tradable sector causing a decline in the output of the tradable goods sector. Non-tradable output falls by as well due to the adverse demand effects that spread in the economy after the decrease in FDI. A reduction in inward FDI prompts a shift in household resource allocation across sectors. This is evident in the provided subplots, where it's observed that private investment in tradable goods experiences a lesser decline compared to private investment in non-tradable goods. This behaviour is primarily influenced by households' response to the decrease in Russian FDI; they compensate by substituting their private investments in domestic tradable goods, $I^{H,H}$. Consequently, this behavior moderates the overall reduction in investments within the tradable goods sector, I^{H}.

Figure 3: Impulse response functions: S1 (baseline model)



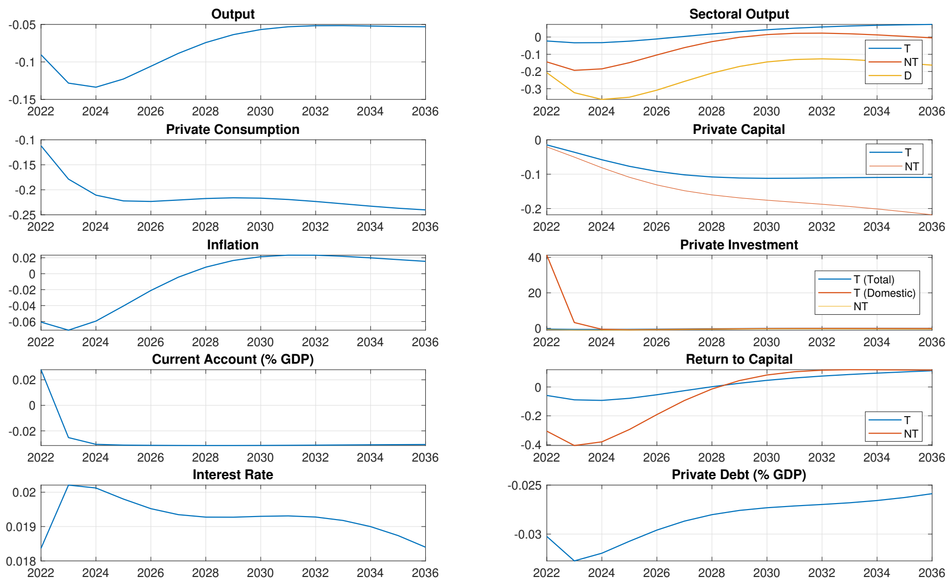
Note: All variables are expressed in % deviations from the initial steady state, except for private foreign debt to GDP which is expressed in absolute deviation from the steady state and the current account to GDP ratio which is expressed in levels.

Figure 4: Impulse response functions: S2 (baseline model)



Note: All variables are expressed in % deviations from the initial steady state, except for private foreign debt to GDP which is expressed in absolute deviation from the steady state the current account to GDP ratio which is expressed in levels.

Figure 5: Impulse response functions: S3 (baseline model)

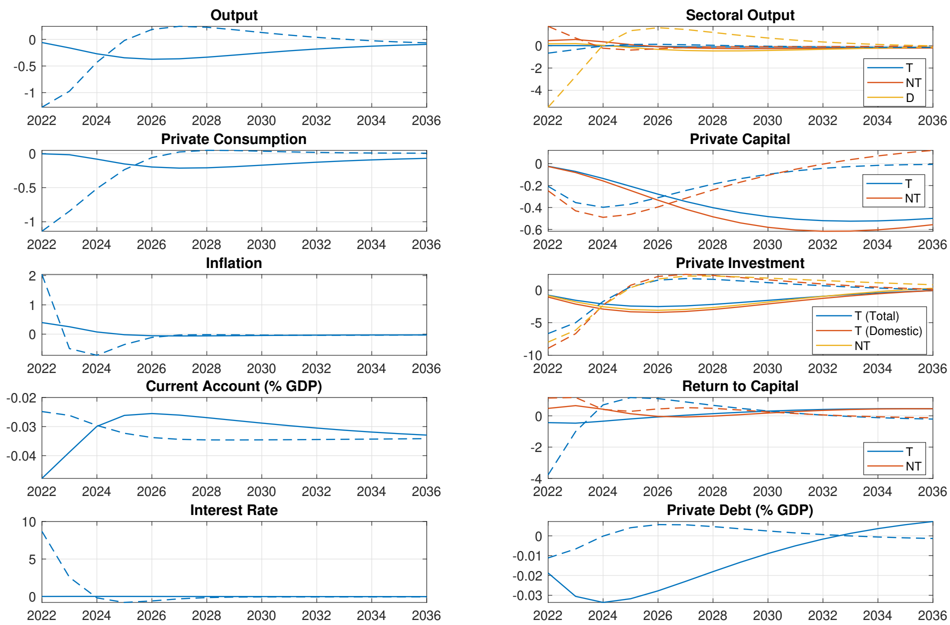


Note: All variables are expressed in % deviations from the initial steady state, except for private foreign debt to GDP which is expressed in absolute deviation from the steady state and the current account to GDP ratio which is expressed in levels.

Transmission mechanism in the financial constraints model Overall, in the presence of adverse demand shocks, households tend to borrow to maintain steady consumption as we already have seen in the context of the baseline model. When there are collateral constraints, eventually private borrowing becomes more difficult, as well as consumption smoothing. As the shocks increases in magnitude, these constraints become more likely to bind. Furthermore households prefer to sell private capital and decrease savings. Consequently, the value of collateral decreases, exacerbating further the borrowing difficulty.

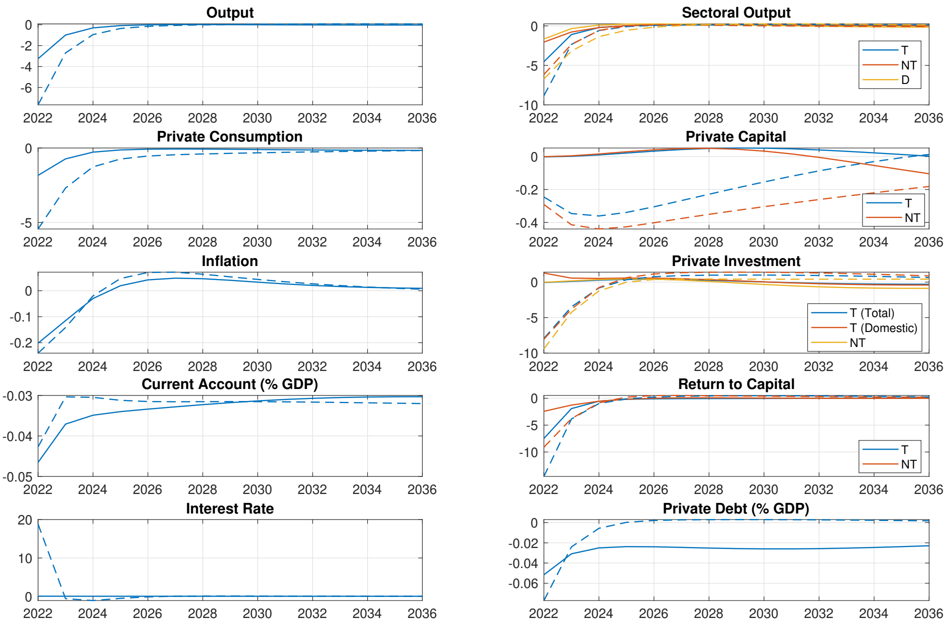
All this can be seen in the subplots of Figures 6 to 8 where the reaction of private foreign debt is clearly mitigated under in each scenario we studied. In fact households not only reduce borrowing but are forced to deleverage which aggravates the contraction. Eventually, the fall in private consumption, private capital and investment is stronger relative to the unconstrained model. Note that the presence of financial constraints harm considerably more the economy when sanctions hit FDI, that is in scenario S3. As can be seen from Table 3 and Figure 8 the effects on output of a negative inward FDI shock are 17 times stronger on impact (-0.09% in the baseline uncostrained model relative to roughly -1.5% in the model with financial frictions) and around 4 times stronger in an average of 5 years post-war. As discussed in Villalvazo (2024), shocks in foreign direct investment flows affect the borrowing capacity because less foreign capital tightens the borrowing constraint of the domestic economy. Thus under such frictions FDI shocks also amplify the final effect on the economy.

Figure 6: Impulse response functions: S1 (financial constraints model)



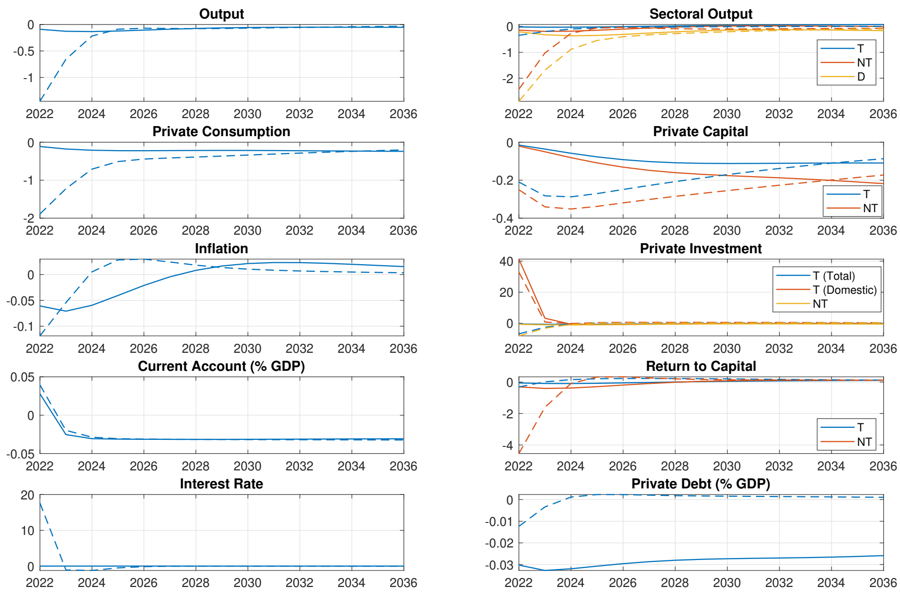
Note: All variables are expressed in % deviations from the initial steady state, except for private foreign debt to GDP which is expressed in absolute deviation from the steady state and the current account to GDP ratio which is expressed in levels. Dashed lines correspond to the augmented model with financial frictions.

Figure 7: Impulse response functions: S2 (financial constraints model)



Note: All variables are expressed in % deviations from the initial steady state, except for private foreign debt to GDP which is expressed in absolute deviation from the steady state and the current account to GDP ratio which is expressed in levels. Dashed lines correspond to the augmented model with financial frictions.

Figure 8: Impulse response functions: S3 (financial constraints model)



Note: All variables are expressed in % deviations from the initial steady state, except for private foreign debt to GDP which is expressed in absolute deviation from the steady state and the current account to GDP ratio which is expressed in levels. Dashed lines correspond to the augmented model with financial frictions.

7 Counterfactuals and sensitivity checks

7.1 Low versus high foreign private indebtedness

As is known Cyprus has a long tradition of a high percentage of non-perfoming loans from both households and firms, which contributes to still-high private sector indebtedness. As also discussed in the previous section tightening financial conditions could increase vulnerability and worsen the reaction of the economy in the presence of adverse shocks such as the sanctions imposed by EU against Russia. In a nonlinear model such as ours, initial conditions may have a non-trivial effect on the results. Given the importance of the collateral channel in the case of foreign debt, it is interesting to analyze how the initial level of indebtedness of households matters for our findings.

To highlight and quantify this we examine a counterfactual scenario in which, we implement the same scenaria (S1, S2 and S3) but this time we compare it with a fictional economy which starts from a much lower external debt position. This is governed by the value of the collateral share parameter κ which is the key factor of initial indebtedness, presumably, of the strength of the collateral channel. To this end, to obtain a value of foreign private debt to GDP ratio from 113% to an ad-hoc value of 25%, the corresponding value of κ has to decrease from 0.23 to 0.05. The rest of the model's elements remain as before. Results for this counterfactual economy are reported in Table 4. The average total drop in output in the low foreign private debt economy is -2.92% . The analogous in the economy with high foreign private debt is -3.36%. Therefore we find that reducing the initial collateral shares decreases the recessionary effects of sanctions by an order of roughly 15%.

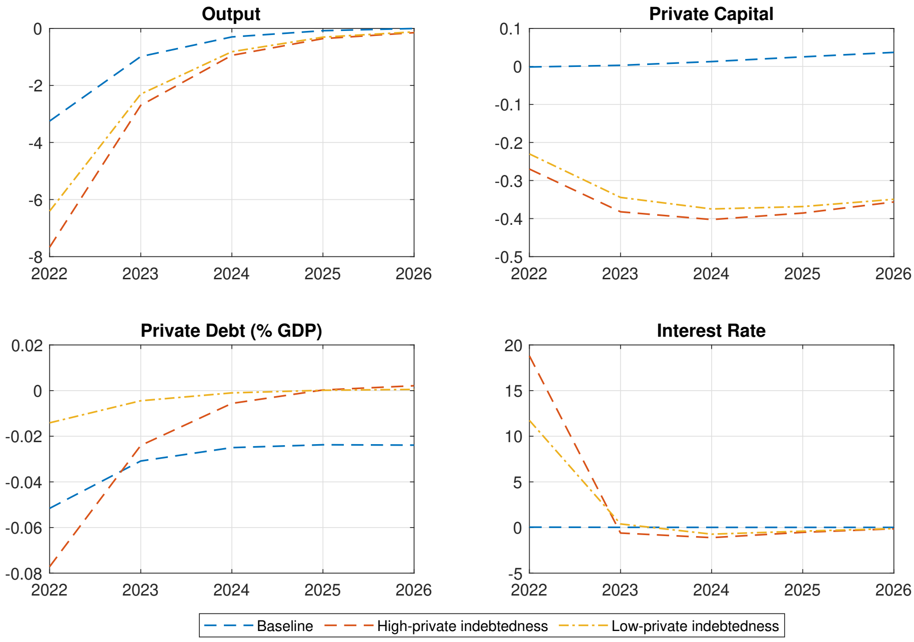
To see this better, in Figure 9 we compare the impulse response functions for selected variables in the low debt economy with the ones in the high debt economy for both the baseline and the financially constrained model. We present the figures only under scenario S2 since this is the one that drives the difference as inferred by comparison of scenarios in Table 4. Thus as the borrowing constraint becomes tighter, the value of collateral will decrease as well. Eventually this will lead result in a non-negligible divergence between the dynamic responses of the model with low and high foreign private indebtedness after imposing adverse foreign shocks. A lower external debt leads also to lower interest rates and hence a crowding in of capital that mitigates the fall in output after an adverse demand shock.

Table 4: Impact on output (average 2022-2026)

	S1	S2	S3	Total
Baseline model	−0.24	−0.92	−0.12	−1.28
Model with financial constraints $\left(\kappa = 0.23, \frac{F}{GDP} = 113\%\right)$	−0.50	−2.36	−0.50	−3.36
Model with financial constraints $\left(\kappa = 0.05, \frac{F}{GDP} = 25\%\right)$	−0.44	−1.99	−0.49	−2.92

Note: Results are expressed in % deviations from the initial steady state

Figure 9: Impulse responses for S2 (varying levels of κ)



Note: All variables are expressed in % deviations from the initial steady state, except for private foreign debt to GDP which is expressed in absolute deviation from the steady state and the current account to GDP ratiowhich is expressed in levels. Dashed lines correspond to the extended model with financial frictions.

7.2 Further sensitivity checks

As is known, in response to sanctions, it is common for countries to turn to alternative markets where as discussed in section 2 data evidence suggests that even though Cyprus's economy took a major hit in terms of exports of travel and financial services, it nevertheless managed to recuperate the loss through exporting travel services to other markets and FDI destinations. In an attempt to mimic what happened in Cyprus's trade and FDI composition, we have performed additional experiments to gauge the sensitivity of the results to e.g. the composition of exports by lowering the adjustments costs of exports parameter or the production factor input substitution (e.g elasticities of substitution between domestic and foreign investment).

We report that again the main results do not change, although one has to bear in mind that such substitution parameters are in general hard to discipline empirically, especially for large changes in the production's input mix so that any analysis is subject to a large degree of uncertainty.[13] For instance elasticity of substitution between domestic and foreign direct investment is likely low in the very short run but larger in the medium and long-run in which Cyprus can differentiate its FDI strategy and attract alternative investors.[14]

[13]Results are available upon request.

[14]See Bachmann *et al.* (2022) on the sensitivity of the elasticity substitution in the context of Germany's energy imports from Russia.

8 Concluding remarks, policy implications and recommendations

This paper examined the consequences of EU sanctions against the Russian Federation on Cyprus's economy, on the basis of Cyprus's historically strong economic connections with Russia. To this end, we utilized a New Keynesian DSGE model of small open economy tailored to the production structure of the Cypriot economy. That is we distinguished between the tradable and non-tradable production sector to reflect the strong intensity of tradable activities such as tourism related and financial and professional services which to a large extent were directed to the Russian Federation, up until the invasion of 2022.

Our analysis contributed to the literature of trade disintegration events and the macroeconomic impact of sanctions across the EU. Although Cyprus does not rely on Russian gas and energy imports, its strong economic interconnectedness with Russia in terms of services exports and FDI prior to the imposition of sanctions by the EU, make the country significant vulnerable to such trade restrictions. Therefore, in terms of economic efficiency sanctions is not a 'one size fits all' policy and the sharing of their burdens across EU countries is not symmetric.

The menu of foreign shocks incorporated into our model to replicate the repercussions of EU sanctions on Russia for Cyprus indicate considerable negative impacts in the short run, perhaps the biggest in EU raising equity issues within the EU about the desirability of trade sanctions as Cyprus has been hit disproportionately compared to other EU member states. This is predominantly driven by the strong trade relation of Cyprus with Russia, the latter being the main receiver of Cyprus's exported services. The overall effect however hinges primarily on uncertainties regarding the sanctions' duration and the war at large. Moreover, our quantitative analysis showed that countries, such as Cyprus, who were already in a critical juncture regarding their external position, face the risk of stronger negative impacts of the ongoing EU sanctions. In our model, when we consider additional financial frictions our results become even worse - the negative impact on output more than doubles. This obviously indicates that adverse exogenous demand and inflationary shocks can make financial conditions even more tight. This is further enhanced by the already high private indebtedness of the Cypriot economy pointing to the necessity of addressing issues like the non performing loans and the persistent high current account deficits.

We close the paper with potential policy recommendations. The current juncture offers a unique opportunity to small economies like Cyprus to move forward to a new growth model. In this regard, and taking lessons from the recent experience of the ongoing Russia-Ukraine war, it is imperative for Cyprus to reorient its services exports to other markets and destinations. Cyprus could leverage its unique geographical location in the Eastern Mediterranean along with its expertise in providing high quality tradable services in tourism and financial intermediation. In turn, the ensuing reduction of public debt and private sector deleveraging will act as buffers against future adverse shocks. Finally as noted in Chowdhry *et al.* (2024) burden-sharing policies such as fiscal transfers, could reduce the asymmetric impact of EU sanctions across different countries, including Cyprus. In this regard the timely and targeted implementation of investments and structural policies through the funds coming from the Recovery and Resilience Plan could alleviate and offset the economic costs from EU sanctions against Russia for the economy of Cyprus.

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Technical Appendix
EU sanctions on Russia and implications for a small open economy: The case of Cyprus

1. Appendix A: Households and firms decisions.
2. Appendix B: Aggregation and Market clearing conditions.
3. Appendix C: Macroeconomic equilibrium.
4. Appendix D: First order conditions of the model with financial constraints.
5. Appendix E: Calibration and data used in the numerical solution.
6. Appendix F: Additional tables and figures.

A Households and firms decisions

A.1 Optimizing households

Each Ricardian household j maximizes its lifetime utility by choosing the consumption good, the portfolio of financial assets, the domestic and foreign government bonds, the end-of-period capital stocks, utilization rates and investments in the traded and non-traded sectors, subject to the its budget constraint. The first-order conditions are given as follows:

$$\Lambda_t = \frac{1}{P_t} \frac{1}{C_t'^R(j) - bC_{t-1}'^R} \frac{1}{(1+\tau_t^C)} \tag{A.1}$$

$$\frac{1}{R_t}\Lambda_t = \beta \mathbb{E}_t \Lambda_{t+1} \tag{A.2}$$

$$\frac{1}{R_t^*}\Lambda_t = \beta \mathbb{E}_t \left(\frac{R_{t+1}^*}{R_{t+1}^*} \Lambda_{t+1} \frac{S_{t+1}}{S_t} \Phi(\cdot) \right) \tag{A.3}$$

$$q_t^H = \beta \mathbb{E}_t \frac{\Lambda_{t+1}}{\Lambda_t} \left[\left(1 - \tau_{t+1}^K\right) r_{t+1}^{k,H} u_{t+1}^H(j) - \Psi\left(u_{t+1}^H(j)\right) + q_{t+1}^H (1-\delta) \right] \tag{A.4}$$

$$q_t^{NT} = \beta \mathbb{E}_t \frac{\Lambda_{t+1}}{\Lambda_t} \left[\left(1 - \tau_{t+1}^K\right) r_{t+1}^{k,NT} u_{t+1}^{NT}(j) - \Psi\left(u_{t+1}^{NT}(j)\right) + q_{t+1}^{NT} (1-\delta) \right] \tag{A.5}$$

$$\begin{aligned} 1 - q_t^H \varepsilon_t^{i,H} & \left\{ 1 - \left(a^F \left(I_t^{H,H}\right)^{a^F-1} \left(I_t^{H,F}\right)^{1-a^F} \right) \left(\Gamma\left(\frac{I_t^H(j)}{I_{t-1}^H(j)}\right) + \Gamma'\left(\frac{I_t^H(j)}{I_{t-1}^H(j)}\right) \frac{I_t^H(j)}{I_{t-1}^H(j)} \right) \right\} \\ = \quad \beta \mathbb{E}_t & \left\{ \frac{\Lambda_{t+1}}{\Lambda_t} q_{t+1}^H \varepsilon_{t+1}^{i,H} \left[\left(a^F \left(I_t^{H,H}\right)^{a^F-1} \left(I_t^{H,F}\right)^{1-a^F} \right) \left(\frac{I_{t+1}^H(j)}{I_t^H(j)} \right)^2 \Gamma'\left(\frac{I_{t+1}^H(j)}{I_t^H(j)} \right) \right] \right\} \end{aligned} \tag{A.6}$$

$$\begin{aligned} 1 - q_t^{NT} \varepsilon_t^{i,NT} & \left\{ 1 - \Gamma\left(\frac{I_t^{NT}(j)}{I_{t-1}^{NT}(j)}\right) - \Gamma'\left(\frac{I_t^{NT}(j)}{I_{t-1}^{NT}(j)}\right) \frac{I_t^{NT}(j)}{I_{t-1}^{NT}(j)} \right\} \\ = \quad \beta \mathbb{E}_t & \left[\frac{\Lambda_{t+1}}{\Lambda_t} q_{t+1}^{NT} \varepsilon_{t+1}^{i,NT} \left(\frac{I_{t+1}^{NT}(j)}{I_t^{NT}(j)} \right)^2 \Gamma'\left(\frac{I_{t+1}^{NT}(j)}{I_t^{NT}(j)} \right) \right] \end{aligned} \tag{A.7}$$

$$\left(1 - \tau_t^K\right) r_t^{k,H} = \Psi'\left(u_t^H(j)\right) \tag{A.8}$$

$$\left(1 - \tau_t^K\right) r_t^{k,NT}(j) = \Psi'\left(u_t^{NT}(j)\right) \tag{A.9}$$

We define $q_t^H \equiv \frac{\Lambda_t^{k^H}}{\Lambda_t}$ and $q_t^{NT} \equiv \frac{\Lambda_t^{k^{NT}}}{\Lambda_t}$ are the prices of capital measured in terms of consumption goods in the traded and non-traded sectors, where Λ_t, $\Lambda_t^{k^H}$, and $\Lambda_t^{k^{NT}}$ are the Lagrange multipliers associated with households' budget constraints.

A.2 Intermediate firms choices in the tradable sector

Then, the firm chooses its price $\tilde{P}_t$, to maximize nominal profits:

$$\max_{\tilde{P}_t^H(h),\tilde{P}_t^X(h)} \mathbb{E}_t \sum_{k=0}^{\infty} \left(\theta^H\right)^k M_{t,t+k} \left\{ \left[\tilde{P}_t^H(h) \left(\prod_{s=1}^{k} \left(\pi_{t+s-1}^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H} \right) - \varepsilon_{t+k}^{p,H} MC_{t+k}^H \right] \left(Y_{t+k}^{H,d}(h) + Y_{t+k}^X(h) \right) \right\}$$

subject to the demand for differentiated goods for domestic consumption and exports:

$$Y_{t+k}^{H,d}(h) + Y_{t+k}^X(h) = \left[\frac{\tilde{P}_t^H(h)}{P_{t+k}^H} \left(\prod_{s=1}^{k} \left(\pi_{t+s-1}^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H} \right) \right]^{-\epsilon^H} \left(Y_{t+k}^{H,d} + Y_{t+k}^X \right)$$

where $\varepsilon_{t+k}^{p,H}$ is a tradable good markup shock that follows a stationary AR(1) process in logs. The resulting first order conditions for $\tilde{P}_t^H(h)$, are given by:

$$\tilde{P}_t^H(h) = \frac{\epsilon^H}{\epsilon^H - 1} \mathbb{E}_t \sum_{k=0}^{\infty} \left\{ \frac{\left(\theta^H\right)^k M_{t,t+k} \left(\prod_{s=1}^{k} \left(\pi_{t+s-1}^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H} \right)^{-\epsilon^H}}{\left(\theta^H\right)^k M_{t,t+k} \left(\prod_{s=1}^{k} \left(\pi_{t+s-1}^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H} \right)^{1-\epsilon^H}} \frac{\varepsilon_{t+k}^{p,H} MC_{t+k}^H \left(P_{t+k}^H\right)^{\epsilon^H} \left(Y_{t+k}^{H,d} + Y_{t+k}^X \right)}{\left(P_{t+k}^H\right)^{\epsilon^H} \left(Y_{t+k}^{H,d} + Y_{t+k}^X \right)} \right\}$$

which states that the price is equal to a markup over the nominal marginal cost of the firm.[15] Similar derivations hold for firms' choices in the non-tradable and imported goods sectors.

B Aggregation

The aggregate quantity, expressed in per-capita terms, of any household specific variable $X_t(j) = \int_0^1 X_t(h)\,dh = (1-\nu) X_t(j) + \nu X_t(j)$. All optimizing households make identical decisions. The same holds and for the Non- Ricardian households. Thus, we can drop the household specific indices i, j.

$$C_t \equiv \int_0^1 C_t(j)\,dj = (1-\nu) C_t^{NR} + \nu C_t^R \tag{B.1}$$

$$L_t = \int_0^1 L_t(j)\,dj = L_t^R = L_t^{NR} \tag{B.2}$$

$$Z_t = \int_0^1 Z_t(j)\,dj = Z_t^R = Z_t^{NR} \tag{B.3}$$

Since only optimizing households have access to the capital, bond, dividend and international markets, the per-capita quantities for private capital, private investment, domestic government bonds, foreign private assets and profits are respectively

$$K_t^T = \nu u_t \bar{K}_t^T(j) \tag{B.4}$$

$$K_t^{NT} = \nu u_t \bar{K}_t^{NT}(j) \tag{B.5}$$

$$B_t = \nu B_t(j) \tag{B.6}$$

$$F_t = \nu F_t(j) \tag{B.7}$$

$$\Pi_t = \nu \Pi_t(j) \tag{B.8}$$

[15]In the absence of nominal rigidities the above formulas reduce to: $\tilde{P}_t^H = \frac{\epsilon^H}{\epsilon^H - 1} \varepsilon_t^{p,H} MC_t^H$

B.1 Market clearing conditions

Market clearing in the capital market Market clearing for capital services across sectors implies that the supply of utilized private capital stocks from households satisfies the demand for private capital services by intermediate good firms

$$u_t \int_0^1 K_t^T(j)dj = u_t K_t^T = u_t \int_0^1 K_t^T(h)dh \tag{B.9}$$

$$u_t \int_0^1 K_t^{NT}(j)dj = u_t K_t^{NT} = \int_0^1 K_t^{NT}(n)dn \tag{B.10}$$

Market clearing in the dividends market

$$\int_0^1 \Pi_t^T(j)dj = \Pi_t^T = u_t \int_0^1 \Pi_t^T(h)dh \tag{B.11}$$

$$\int_0^1 \Pi_t^{NT}(j)dj = \Pi_t^{NT} = \int_0^1 \Pi_t^{NT}(\text{u})dn \tag{B.12}$$

Market clearing in the intermediate goods sector The supply of each differentiated good h needs to meet domestic and foreign demand:

$$Y_t^H(h) = Y_t^D(h) + Y_t^X(h) \tag{B.13}$$

Aggregating over the continuum of intermediate good firms we get the aggregate resource constraint:

$$Y_t^H = \int_0^1 Y_t^H dh(h) = \int_0^1 Y_t^D(h)\,dh + \int_0^1 Y_t^X(h)\,dh = \int_0^1 \left(\frac{P_t^H(h)}{P_t^H}\right)^{\frac{\epsilon^x-1}{\epsilon^x}} Y_t^H dh + \int_0^1 \left(\frac{P_t^X(h)}{P_t^X}\right)^{\frac{\epsilon^x-1}{\epsilon^x}} Y_t^X dh \tag{B.14}$$

or

$$Y_t^H = \Delta_t^H \left(Y_t^H + Y_t^X\right) \tag{B.15}$$

where $\Delta_t^H = \int_0^1 \left(\frac{P_t^H(h)}{P_t^H}\right)^{\frac{\epsilon^H-1}{\epsilon^H}} dh$ measures the degree of price dispersion across the differentiated goods that are sold in the domestic and foreign markets. We can also use the Calvo assumption to break up the price dispersion term, by again noting that $(1-\theta^H)$of firms will update to the same price, and θ firms will be stuck with last period's price.

$$\Delta_t^H = \left(1-\theta^H\right)\left(\tilde{P}_t^H\right)^{-\epsilon^H} + \theta^H \left[P_{t-1}^H \left(\pi_{t-1}^H\right)^{\lambda^H}\right]^{-\epsilon^H} \Delta_{t-1}^H \tag{B.16}$$

Market clearing in the market of imported intermediate goods The supply of each differentiated importing good f m needs to meet domestic demand:

$$Y_t^F = \int_0^1 Y_t^F(f)\,df = \int_0^1 Y_t^F(h)\,df = \int_0^1 \left(\frac{P_t^F(f)}{P_t^F}\right)^{\frac{\epsilon^F-1}{\epsilon^X}} Y_t^F df \tag{B.17}$$

or

$$Y_t^F = \Delta_t^F Y_t^F \tag{B.18}$$

where $\Delta_t^F = \int_0^1 \left(\frac{P_t^F(f)}{P_t^F}\right)^{\frac{\epsilon^F-1}{\epsilon^F}} df$ measures the degree of price dispersion across the differentiated goods that are sold in the imported goods market.

$$\Delta_t^F = \left(1-\theta^F\right)\left(\tilde{P}_t^F\right)^{-\epsilon^F} + \theta^F\left[P_{t-1}^F\left(\pi_{t-1}^F\right)^{\lambda^F}\right]^{-\epsilon^F}\Delta_{t-1}^F \tag{B.19}$$

Market clearing in the final goods markets The aggregate demand for final goods is, therefore, made of the consumption of all households, investments to both the trade and non-tradable sectors, capital utilisation costs and government consumption:

$$Y_t = \nu C_t^R + (1-\nu)\, C_t^{NR} + \nu I_t^H + \nu I_t^{NT} + \nu\eta\left(u_t^H\right)\bar{K}_{t-1}^H + \nu\eta\left(u_t^{NT}\right)\bar{K}_{t-1}^{NT} + G_t^c \tag{B.20}$$

C Macroeconomic equilibrium

We solve for a decentralized competitive equilibrium (DCE) in which: (i) Ricardian households maximize welfare; (ii) a fraction $1-\theta^{H,NT}$ of intermediate good (tradable and non tradable) firms maximize profits in the domestic and foreign markets, a fraction $1-\theta^F$ of importing firms maximize profits in the domestic market and the rest of the firms set their prices according to the respective indexation schemes; (iii) final good firms maximize profits; (iv) all constraints are satisfied; and (v) all markets clear.

We re-express nominal marginal costs to their real terms, $mc_t^H = \frac{MC_t^H}{P_t}$, $mc_t^{NT} = \frac{MC_t^{NT}}{P_t}$, and nominal prices in terms of relative prices or inflation rates: $p_t^T = \frac{P_t^T}{P_t}$, $p_t^F = \frac{P_t^F}{P_t}$, $p_t^* = \frac{P_t^*}{P_t}$, $p_t^H = \frac{P_t^H}{P_t}$, $p_t^{NT} = \frac{P_t^{NT}}{P_t}$, $\widetilde{p}_t^H = \frac{\widetilde{P}_t^H}{P_t^H}$, $\widetilde{p}_t^{NT} = \frac{\widetilde{P}_t^{NT}}{P_t^{NT}}$, $\widetilde{p}_t^F = \frac{\widetilde{P}_t^F}{P_t^F}$, $\pi_t = \frac{P_t}{P_{t-1}}$, $\pi_t^H = \frac{P_t^H}{P_{t-1}^H}$, $\pi_t^{NT} = \frac{P_t^{NT}}{P_{t-1}^{NT}}$, $\pi_t^* = \frac{P_t^*}{P_{t-1}^*}$, $\epsilon_t = \frac{S_t}{S_{t-1}}$ and $R_t^x = \frac{S_t P_t^*}{P_t}$.

Under the assumed monetary and fiscal policy regimes, the system consists of 68 equations in 68 endogenous variables expressed in real terms: $\{C_t^R$, $C_t'^R$, C_t^{NR}, Λ_t, $\bar{K}_t^H$, $\bar{K}_t^{NT}$, K_t^H, K_t^{NT},I_t^H, $I_t^{H,H}$, I_t^{NT}, q_t^H, q_t^{NT},Y_t^{GDP}, Y_t, Y_t^T, Y_t^{NT}, Y_t^F, Y_t^H, Y_t^D, Y_t^X, Y_t^*, Z_t, G_t^C, u_t^{TH}, u_t^{NT}, $r_t^{k,H}$, $r_t^{k,NT}$, R_t, R_t^*, w_t, w_t^1, w_t^2,W_t^H, W_t^{NT}, $\tilde{w}_t$, L_t, L_t^H, L_t^{NT}, L_t^G, mc_t^T, mc_t^{NT}, Δ_t^H, Δ_t^{NT}, Δ_t^F, F_t, F_t^G, D_t, τ_t, R_t^x, p_t^T, p_t^F, p_t^H, $p_t^{1,H}$, $p_t^{2,H}$, p_t^{NT}, $p_t^{1,NT}$, $p_t^{2,NT}$, $\widetilde{p}_t^H$, $\widetilde{p}_t^{NT}$, $\widetilde{p}_t^F$, π_t π_t^H, π_t^{NT}, π_t^F, $gap_t\}$. This is given the paths of fiscal instruments $\{s_t^{G^C}$, s_t^Z, τ_t^C, τ_t^K, $\tau_t^L\}$, the fractions of public debt held by private agents abroad and EU institutions λ_t^G, λ_t^{EU}, the population shares ν, $1-\nu$, the foreign prices p^F, and the exchange rate S.

- The FOC w.r.t. consumption:

$$\Lambda_t\left(1+\tau_t^C\right) = \frac{1}{C_t'^R - hC_{t-1}'^R} \tag{C.1}$$

- Definition of $C_t'^R$:

$$C_t'^R = C_t^R + \theta^g Y_t^G \tag{C.2}$$

- The stochastic discount factor:

$$\mathbb{E}_t M_{t,t+1} = \mathbb{E}_t\left(\beta\frac{\Lambda_{t+1}}{\Lambda_t}\frac{1}{\pi_{t+1}}\right)$$

- The FOC w.r.t. long-term domestic bond:

$$\mathbb{E}_t\left(\beta\frac{\Lambda_{t+1}}{\Lambda_t}\frac{1}{\pi_{t+1}}R_t\right) = 1 \tag{C.3}$$

- The FOC w.r.t. long-term foreign bond:

$$\mathbb{E}_t\left(\beta R_t^*\frac{\Lambda_{t+1}}{\Lambda_t}\frac{1}{\pi_{t+1}}\frac{S_{t+1}}{S_t}\Phi(\cdot)\right) = 1 \tag{C.4}$$

where

$$\Phi(\cdot) = \left[1+\psi\left(e^{(a_t-\bar{a})}-1\right)\right] \text{ and } a_t \equiv \frac{R_t^x\left(F_t^G - F_t\right)}{Y_t^{GDP}}$$

- Ricardian Household's FOC w.r.t. capital for traded sector:

$$q_t^H = \mathbb{E}_t \left\{ \beta \frac{\Lambda_{t+1}}{\Lambda_t} \left[\left(1 - \tau_{t+1}^K\right) r_{t+1}^{k,H} u_{t+1}^H - \Psi\left(u_{t+1}^H\right) + (1-\delta)\, q_{t+1}^H \right] \right\} \tag{C.5}$$

- Ricardian Household's FOC w.r.t. capital for non-traded sector:

$$q_t^{NT} = \mathbb{E}_t \left\{ \beta \frac{\Lambda_{t+1}}{\Lambda_t} \left[\left(1 - \tau_{t+1}^K\right) r_{t+1}^{k,NT} u_{t+1}^{NT} - \Psi\left(u_{t+1}^{NT}\right) + (1-\delta)\, q_{t+1}^{NT} \right] \right\} \tag{C.6}$$

- Ricardian Household's FOC w.r.t. investment for traded sector:

$$\begin{aligned} 1 - q_t^H \varepsilon_t^{i,H} & \left\{ 1 + \left(a^F \left(I_t^{H,H}\right)^{a^F - 1} \left(I_t^{H,F}\right)^{1-a^F} \right) \left(-\frac{v_i}{2} \left(\frac{I_t^H}{I_{t-1}^H} - 1 \right)^2 - v_i \left(\frac{I_t^H}{I_{t-1}^H} - 1 \right) \frac{I_t^H}{I_{t-1}^H} \right) \right\} \quad \text{(C.7)} \\ = & \; \mathbb{E}_t \left\{ \beta \frac{\Lambda_{t+1}}{\Lambda_t} q_{t+1}^H \varepsilon_{t+1}^{i,H} \left[v_i \left(\frac{I_{t+1}^H}{I_t^H} - 1 \right) \left(\frac{i_{t+1}^H}{I_t^H} \right)^2 \left(a^F \left(I_t^{H,H}\right)^{a^F-1} \left(I_t^{H,F}\right)^{1-a^F} \right) \right] \right\} \end{aligned}$$

- Ricardian Household's FOC w.r.t. investment for non-traded sector

$$\begin{aligned} 1 - q_t^{NT} \varepsilon_t^{i,NT} & \left\{ 1 - \frac{v_i}{2} \left(\frac{I_t^{NT}}{I_{t-1}^{NT}} - 1 \right)^2 - v_i \left(\frac{I_t^{NT}}{I_{t-1}^{NT}} - 1 \right) \frac{I_t^{NT}}{I_{t-1}^{NT}} \right\} \\ = & \; \mathbb{E}_t \left\{ \beta \frac{\Lambda_{t+1}}{\Lambda_t} q_{t+1}^{NT} \varepsilon_{t+1}^{i,NT} \left[v_i \left(\frac{I_{t+1}^{NT}}{I_t^{NT}} - 1 \right) \right] \left(\frac{I_{t+1}^{NT}}{I_t^{NT}} \right)^2 \right\} \end{aligned} \tag{C.8}$$

- FOC w.r.t. utilisation capacity for traded sector

$$\left(1 - \tau_t^K\right) r_t^{k,H} = \Psi'\left(u_t^H\right) \tag{C.9}$$

- FOC w.r.t. utilisation capacity for non-traded sector

$$\left(1 - \tau_t^K\right) r_t^{k,NT} = \Psi'\left(u_t^{NT}\right) \tag{C.10}$$

- The law of motion for capital for traded sector

$$\bar{K}_t^H = (1-\delta)\, \bar{K}_{t-1}^H + \varepsilon_t^{i,H} \left[1 - \frac{v_i}{2} \left(\frac{I_t^H}{I_{t-1}^H} - 1 \right)^2 \right] I_t^H \tag{C.11}$$

- Foreign direct investment

$$I_t^H = \left[(\omega^F)^{\frac{1}{a^F}} (I_t^{H,H})^{\frac{\alpha^F - 1}{\alpha^F}} + (1-\omega^F)^{\frac{1}{a^F}} \left(I_t^{H,F}\right)^{\frac{\alpha^F-1}{\alpha^F}} \right]^{\frac{a^F}{a^F - 1}} \tag{C.12}$$

- The law of motion for capital for non-traded sector

$$\bar{K}_t^{NT} = (1-\delta)\, \bar{K}_{t-1}^{NT} + \varepsilon_t^{i,NT} \left[1 - \frac{v_i}{2} \left(\frac{I_t^{NT}}{I_{t-1}^{NT}} - 1 \right)^2 \right] I_t^{NT} \tag{C.13}$$

- Non-Ricardian households budget constraint

$$\left(1+\tau_t^C\right) C_t^{NR} = \left(1-\tau_t^L\right) w_t L_t + Z_t \tag{C.14}$$

- Optimal wage set by the Ricardian household (we use the recursive form)

$$\tilde{w}_t\left(l\right)^{1+\varepsilon^W\kappa} = \frac{\varepsilon^W}{\varepsilon^W-1}\frac{w_t^1}{w_t^2} \tag{C.15}$$

$$w_t^1 = \frac{1}{1-\tau_t^L}\varepsilon_t^W w_t^{\varepsilon^W(1+\kappa)} L_t^{1+\kappa} + \beta\theta^W \left(\frac{\pi_{t+1}}{(\pi_t)^{\lambda^W}(\pi)^{1-\lambda^W}}\right)^{\varepsilon^W(1+\kappa)} \mathbb{E}_t w_{t+1}^1 \tag{C.16}$$

$$w_t^2 = \lambda_t \left(w_t\right)^{\varepsilon^W} L_t + \beta\theta^W \left(\frac{\pi_{t+1}}{(\pi_t)^{\lambda^W}(\pi)^{1-\lambda^W}}\right)^{\varepsilon^W-1} \mathbb{E}_t w_{t+1}^2 \tag{C.17}$$

- Aggregate wage evolution:

$$w_t = \left[\left(1-\theta^W\right)\left(\tilde{w}_t\right)^{1-\varepsilon^W} + \theta^W\left(w_{t-1}\frac{(\pi_{t-1})^{\lambda^W}(\pi)^{1-\lambda^W}}{\pi_t}\right)^{1-\varepsilon^W}\right]^{\frac{1}{1-\varepsilon^W}} \tag{C.18}$$

- Aggregate wage equation:

$$w_t = \left[\phi^H\left(w_t^H\right)^{1+\mu^W} + (1-\phi^H)\left(w_t^{NT}\right)^{1+\mu^W}\right]^{\frac{1}{1+\mu^W}} \tag{C.19}$$

- Hours worked in the tradable sector:

$$L_t^H = \phi^H\left(\frac{w_t^H}{w_t}\right)^{\mu^W} L_t \tag{C.20}$$

- Hours worked in the non-tradable sector:

$$L_t^{NT} = \left(1-\phi^H\right)\left(\frac{w_t^{NT}}{w_t}\right)^{\mu^W} L_t \tag{C.21}$$

- The production function of wholesale firms:

$$Y_t = \left[\omega^{\frac{1}{z}}\left(Y_t^T\right)^{\frac{z-1}{z}} + (1-\omega)^{\frac{1}{z}}\left(Y_t^{NT}\right)^{\frac{z-1}{z}}\right]^{\frac{z}{z-1}} \tag{C.22}$$

- The optimal demand of traded and non-traded goods:

$$\frac{Y_t^T}{Y_t^{NT}} = \frac{\omega}{1-\omega}\left(\frac{p_t^T}{p_t^{NT}}\right)^{-z} \tag{C.23}$$

- The price-setting equation:

$$1 = \left[\omega\left(p_t^T\right)^{1-z} + (1-\omega)\left(p_t^{NT}\right)^{1-z}\right]^{\frac{1}{1-z}} \tag{C.24}$$

- The production function of the composite tradable goods:

$$Y_t^T = \left[\left(\omega^H\right)^{\frac{1}{z^H}} \left(Y_t^D\right)^{\frac{z^H-1}{z^H}} + \left(1-\omega^H\right)^{\frac{1}{z^H}} \left((1-\Gamma_F(Y_t^F/Y_t^T;\varepsilon_t^F))Y_t^F\right)^{\frac{z^H-1}{z^H}} \right]^{\frac{z^H}{z^H-1}} \tag{C.25}$$

- The optimal demand of home traded and foreign goods:

$$\frac{Y_t^D}{Y_t^F} = \frac{\omega^H}{(1-\omega^H)\left(1-\Gamma_F(Y_t^F/Y_t^T;\varepsilon_t^F)\right)^{\zeta^H-1}} \left(\frac{p_t^H}{p_t^F}\right)^{-z^H} \tag{C.26}$$

- The price index of the composite tradable good:

$$p_t^T = \left[\omega^H \left(p_t^H\right)^{1-z^H} + \left(1-\omega^H\right) \left(\frac{p_t^F}{\Gamma_F^{\dagger}(Y_t^F/Y_t^T;\varepsilon_t^F)}\right)^{1-z^H} \right]^{\frac{1}{1-z^H}} \tag{C.27}$$

- The marginal production cost for intermediated tradable goods:

$$mc_t^H = \frac{\left(r_t^{k,H}\right)^{a^H} \left[(1+\tau_t^{PR})w_t^H\right]^{1-a^H}}{A^H \left(a^H\right)^{a^H} \left(1-a^H\right)^{1-a^H}} \tag{C.28}$$

- The optimal capital-labour ratio:

$$\frac{\nu u_t^H \bar{K}_{t-1}^H}{L_t^H} = \frac{a^H}{1-a^H} \frac{(1+\tau_t^{PR})w_t^H}{r_t^{k,H}} \tag{C.29}$$

- The production function:

$$Y_t^H \Delta_t^H = A_t^H \left(\nu u_t^H \bar{K}_{t-1}^H\right)^{a^H} \left(L_t^H\right)^{1-a^H} \tag{C.30}$$

- The price-setting equation

$$\tilde{P}_t^H = \frac{\epsilon^H}{\epsilon^H - 1} \frac{p_t^{1,H}}{p_t^{2,H}}. \tag{C.31}$$

$$p_t^{1,H} = \varepsilon_t^{p,H} mc_t^H \left(Y_t^D + Y_t^X\right) + \beta\theta^H \frac{\Lambda_{t+1}}{\Lambda_t} \left(\frac{\pi_{t+1}^H}{\left(\pi_t^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H}}\right)^{\epsilon^H} \mathbb{E}_t p_{t+1}^{1,H} \tag{C.32}$$

$$p_t^{2,H} = p_t^H \left(Y_t^D + Y_t^X\right) + \beta\theta^H \frac{\Lambda_{t+1}}{\Lambda_t} \left(\frac{\pi_{t+1}^H}{\left(\pi_t^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H}}\right)^{\epsilon^H-1} \mathbb{E}_t p_{t+1}^{2,H} \tag{C.33}$$

- The evolution of the price level of tradables is:

$$1 = (1 - \theta^H) \left(\tilde{p}_t^H\right)^{1-\epsilon^H} + \theta^H \left[\frac{\left(\pi_{t-1}^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H}}{\pi_t^H} \right]^{1-\epsilon^H} \tag{C.34}$$

- The price dispersion index for traded sector:

$$\Delta_t^H = (1 - \theta^H) \left(\tilde{p}_t^H\right)^{-\epsilon^H} + \theta^H \left[\frac{\left(\pi_{t-1}^H\right)^{\lambda^H} \left(\pi^H\right)^{1-\lambda^H}}{\pi_t^H} \right]^{-\epsilon^H} \Delta_{t-1}^H \tag{C.35}$$

- The marginal production cost for intermediated non-tradable goods:

$$mc_t^{NT} = \frac{1}{A^{NT}} \frac{\left(r_t^{k,NT}\right)^{a^{NT}} \left[(1 + \tau_t^{PR}) w_t^{NT}\right]^{1-a^{NT}}}{\left(a^{NT}\right)^{a^{NT}} \left(1 - a^{NT}\right)^{1-a^{NT}}} \tag{C.36}$$

- The optimal capital-labour ratio:

$$\frac{\nu u_t^{NT} \bar{K}_{t-1}^{NT}}{L_t^{NT}} = \frac{a^{NT}}{1 - a^{NT}} \frac{(1 + \tau_t^{PR}) w_t^{NT}}{r_t^{k,NT}} \tag{C.37}$$

- The production function:

$$Y_t^{NT} \Delta_t^{NT} = A_t^{NT} \left(\nu u_t^{NT} \bar{K}_{t-1}^{NT}\right)^{a^{NT}} \left(L_t^{NT}\right)^{1-a^{NT}} \tag{C.38}$$

- The price-setting equation:

$$\widetilde{p}_t^{NT} = \frac{\epsilon^{NT}}{\epsilon^{NT} - 1} \frac{p_t^{1,NT}}{p_t^{2,NT}}. \tag{C.39}$$

$$p_t^{1,NT} = \varepsilon_t^{p,NT} mc_t^{NT} Y_t^{NT} + \beta \theta^{NT} \frac{\Lambda_{t+1}}{\Lambda_t} \left(\frac{\pi_{t+1}^{NT}}{\left(\pi_t^{NT}\right)^{\lambda^{NT}} \left(\pi^{NT}\right)^{1-\lambda^{HNT}}} \right)^{\epsilon^{NT}} \mathbb{E}_t p_{t+1}^{1,NT} \tag{C.40}$$

$$p_t^{2,NT} = p_t^{NT} Y_t^{NT} + \beta \theta^{NT} \frac{\Lambda_{t+1}}{\Lambda_t} \left(\frac{\pi_{t+1}^{NT}}{\left(\pi_t^{NT}\right)^{\lambda^{NT}} \left(\pi^{NT}\right)^{1-\lambda^{NT}}} \right)^{\epsilon^{NT}-1} \mathbb{E}_t p_{t+1}^{2,NT} \tag{C.41}$$

- The evolution of the price level of nontradables is:

$$1 = (1 - \theta^{NT}) \left(\tilde{p}_t^{NT}\right)^{1-\epsilon^{NT}} + \theta^{NT} \left[\frac{\left(\pi_{t-1}^{NT}\right)^{\lambda^{NT}} \left(\pi^{NT}\right)^{1-\lambda^{NT}}}{\pi_t^{NT}} \right]^{1-\epsilon^{NT}} \tag{C.42}$$

- The price dispersion index for non-traded sector:

$$\Delta_t^{NT} = (1 - \theta^{NT}) \left(\tilde{p}_t^{NT}\right)^{-\epsilon^{NT}} + \theta^{NT} \left[\frac{\left(\pi_{t-1}^{NT}\right)^{\lambda^{NT}} \left(\pi^{NT}\right)^{1-\lambda^{NT}}}{\pi_t^{NT}} \right]^{-\epsilon^{NT}} \Delta_{t-1}^{NT} \tag{C.43}$$

- Government budget constraint:

$$D_t = \frac{R_t \lambda_t^D D_{t-1}}{\pi_t} + \frac{R_t^* \lambda_t^G D_{t-1} R_t^x}{\pi_t^*} + \frac{R^{EU} \lambda_t^{EU} R_t^x D_{t-1}}{\pi_t^*} + G_t + Z_t - REV_t \tag{C.44}$$

- Total revenues:

$$REV_t = \tau_t^C \left[\nu C_t^R + (1-\nu) C_t^{NR} \right] + (\tau_t^L + \tau_t^{PR}) w_t L_t + \tau_t^K \nu \left[r_t^{k,H} u_t^H \bar{K}_{t-1}^H + r_t^{k,NT} u_t^{NT} \bar{K}_{t-1}^{NT} \right] \tag{C.45}$$

- Total government spending:
- Definition of GDP:

$$Y_t^{GDP} \equiv p_t^H Y_t^D + p_t^H Y_t^X + p_t^{NT} Y_t^{NT} \tag{C.46}$$

- Final goods market equilibrium:

$$Y_t = \nu C_t^R + (1-\nu) C_t^{NR} + \nu I_t^H + \nu I_t^{NT} + \nu \Psi \left(u_t^H \right) \bar{K}_{t-1}^H + \nu \Psi \left(u_t^{NT} \right) \bar{K}_{t-1}^{NT} + G_t^C + G_t^I \tag{C.47}$$

- Tradable good market:

$$Y_t^H = Y_t^D + Y_t^X \tag{C.48}$$

- Balance of payments:

$$R_t^x \left(\frac{\nu F_t - \left(\lambda_t^G + \lambda_t^{EU} \right) D_t}{\Phi(\cdot)} \right) = \frac{R_t^x R_{t-1}^* \left(\frac{\nu F_{t-1} - \lambda_t^G D_{t-1}}{\Phi(\cdot)} \right)}{\pi_t^*} - \frac{R_t^x R_{t-1}^{EU} \lambda_t^{EU} D_{t-1}}{\pi_t^*} + p_t^H Y_t^X - p_t^F Y_t^F + \nu I_t^{H,F} \tag{C.49}$$

- Debt-elastic interest rate:

$$R_t^* = \tilde{R}_t^* + \psi^d \left(e^{s_t^D - \mathcal{D}} - 1 \right) , \tag{C.50}$$

- The world demand function:

$$Y_t^X = \left(\frac{p_t^H}{R_t^x \Gamma_X^\dagger (Y_t^X / Y_t^*; \varepsilon_t^X)} \right)^{-z^x} \frac{Y_t^*}{1 - \Gamma_X (Y_t^X / Y_t^*; \varepsilon_t^X)} \tag{C.51}$$

- Law of one price gap

$$gap_t = \frac{R_t^x}{P_t^F} < 1 \tag{C.52}$$

- Price-setting equations of importing firms:

$$\tilde{p}_t^F = \frac{\epsilon^F}{\epsilon^F - 1} \frac{p_t^{1,F}}{p_t^{2,F}} \tag{C.53}$$

$$p_t^{1,F} = \varepsilon_t^{p,F} gap_t p_t^F Y_t^F + \beta\theta^F \frac{\Lambda_{t+1}}{\Lambda_t} \left(\frac{\pi_{t+1}^F}{\left(\pi_t^F\right)^{\lambda^F} \left(\pi^F\right)^{1-\lambda^F}} \right)^{\epsilon^F} \mathbb{E}_t p_{t+1}^{1,F} \tag{C.54}$$

$$p_t^{2,F} = p_t^F Y_t^F + \beta\theta^F \frac{\Lambda_{t+1}}{\Lambda_t} \left(\frac{\pi_{t+1}^F}{\left(\pi_t^F\right)^{\lambda^F} \left(\pi^F\right)^{1-\lambda^F}} \right)^{\epsilon^F - 1} \mathbb{E}_t p_{t+1}^{2,F} \tag{C.55}$$

- Evolution of general price of imported goods:

$$1 \equiv (1 - \theta^F) \left(\widetilde{p}_t^F\right)^{1-\epsilon^F} + \theta^F \left[\frac{\left(\pi_{t-1}^F\right)^{\lambda^F} \left(\pi^F\right)^{1-\lambda^F}}{\pi_t^F} \right]^{1-\epsilon^F}. \tag{C.56}$$

- The price dispersion index for imported goods:

$$\Delta_t^F = (1 - \theta^F) \left(\tilde{p}_t^F\right)^{-\epsilon^F} + \theta^F \left[\frac{\left(\pi_{t-1}^F\right)^{\lambda^F} \left(\pi^F\right)^{1-\lambda^F}}{\pi_t^F} \right]^{-\epsilon^F} \Delta_{t-1}^F \tag{C.57}$$

- Definition of home tradable inflation:

$$p_t^H = \frac{\pi_t^H}{\pi_t} p_{t-1}^H \tag{C.58}$$

- Definition of non-tradable inflation:

$$p_t^{NT} = \frac{\pi_t^{NT}}{\pi_t} p_{t-1}^{NT} \tag{C.59}$$

- Definition of imported inflation

$$p_t^F = \frac{\pi_t^F}{\pi_t} p_{t-1}^F \tag{C.60}$$

- Definition of real exchange rate:

$$R_t^x = \epsilon_t \frac{\pi_t^*}{\pi_t} R_{t-1}^x \tag{C.61}$$

- Definition of total public debt to GDP ratio:

$$D_t = \frac{B_t + R_t^x F_t}{Y_t^{GDP}} \tag{C.62}$$

- Definition of government consumption:

$$G_t^C = s_t^{G^C} Y_t^{GDP} \tag{C.63}$$

- Definition of lump-sum transfers:

$$Z_t = s_t^Z Y_t^{GDP} \tag{C.64}$$

- Effective capital of tradable sector:

$$K_t^H = \nu u_t^H \bar{K}_{t-1}^H \tag{C.65}$$

- Effective capital of non-tradable sector:

$$K_t^{NT} = \nu u_t^{NT} \bar{K}_{t-1}^{NT} \tag{C.66}$$

Additional equations

- Fiscal rules:

$$\frac{\chi_t}{\chi} = \left(\frac{\chi_{t-1}}{\chi}\right)^{\rho^{\chi}} \left(\frac{s^D_{t-1}}{s^D}\right)^{(1-\rho^{\chi})\gamma^{\chi}} \tag{C.67}$$

where $\chi \in \{ G^I_t, G^C_t, Z_t, \tau^C_t, \tau^L_t, \tau^K_t \}$

- Evolution of technology:

$$\log A^s_t = \rho^{A^s} \log A^s_{t-1} + \varepsilon^{A^s}_t \tag{C.68}$$

where $s = \{T, NT\}$

- Evolution of export demand shock:

$$\log\left(Y^*_t\right) = \rho^{y^*} \log\left(Y^*_{t-1}\right) + \varepsilon^{y^*}_t \tag{C.69}$$

- Evolution of cost-push shock:

$$\log\left(\varepsilon^{p,F}_t\right) = \rho^{\varepsilon^{p,F}} \log\left(\varepsilon^{p,F}_{t-1}\right) + \varepsilon^{\varepsilon^{p,F}}_t \tag{C.70}$$

- Evolution of inward FDI:

$$s^{FDI}_t = \rho^{FDI} s^{FDI}_{t-1} + \varepsilon^{FDI}_t \tag{C.71}$$

- Definition of adjustment cost for imports:

$$\Gamma_F(Y^F_t/Y^T_t; \varepsilon^F_t) \equiv \frac{\gamma^F}{2}\left((\varepsilon^F_t)^{-\frac{1}{\gamma^F}} \frac{Y^F_t/Y^F_{t-1}}{Y^T_t/Y^T_{t-1}} - 1\right)^2 \tag{C.72}$$

- Definition of adjustment cost for changing the composition of exports:

$$\Gamma_X(Y^X_t/Y^*_t; \varepsilon^X_t) \equiv \frac{\gamma^X}{2}\left((\varepsilon^X_t)^{-\frac{1}{\gamma^X}} \frac{Y^X_t/Y^X_{t-1}}{Y^*_t/Y^*_{t-1}} - 1\right)^2 \tag{C.73}$$

D First order conditions in the model with financial constraints

Under the presence of the collateral constraint, the following first order conditions of the Ricardian household should be appropriately modified:

- The FOC w.r.t. long-term foreign bond:

$$\mathbb{E}_t \left(\beta R_t^* \frac{\Lambda_{t+1}}{\Lambda_t} \frac{1}{\pi_{t+1}} \frac{S_{t+1}}{S_t} \Phi\left(\cdot\right) \right) = 1 - \mu_t \tag{D.1}$$

- Ricardian Household's FOC w.r.t. capital for traded sector:

$$q_t^H - \mu_t \kappa u_t^H = \mathbb{E}_t \left\{ \beta \frac{\Lambda_{t+1}}{\Lambda_t} \left[\left(1 - \tau_{t+1}^K\right) r_{t+1}^{k,H} u_{t+1}^H - \Psi\left(u_{t+1}^H\right) + \left(1 - \delta\right) q_{t+1}^H \right] \right\} \tag{D.2}$$

- Ricardian Household's FOC w.r.t. capital for non-traded sector:

$$q_t^{NT} - \mu_t \kappa u_t^{NT} = \mathbb{E}_t \left\{ \beta \frac{\Lambda_{t+1}}{\Lambda_t} \left[\left(1 - \tau_{t+1}^K\right) r_{t+1}^{k,NT} u_{t+1}^{NT} - \Psi\left(u_{t+1}^{NT}\right) + \left(1 - \delta\right) q_{t+1}^{NT} \right] \right\} \tag{D.3}$$

where $\mu_t > 0$ is the Lagrange multiplier associated with the collateral constraint.

E Calibration and data used in the numerical solution

This section parameterizes the model described in the previous sections using data for the Cypriot economy for the period 2009-2019. In turn, using these parameter values we present the resulting numerical stationary solution for the model's initial steady state which serves as the departure point for our policy experiments. The baseline parameter values, as well as the values of the fiscal policy variables, are listed in Table 5. We obtain the data from Eurostat, AMECO, Cyprus Statistical Authority, OECD-TiVA accounts and the World Input-Output database (WIOD).

Population composition We set the fraction of rule of thumb households, $(1 - \nu)$ equal to 0.5 which is broadly consistent with the values reported in (Coenen *et al.*, 2012) and The Household Finance and Consumption Survey.

Preferences The time unit is meant to be one year. In calibrating the model, we assume that the economy is in its initial steady state with zero inflation. We set the gross interest rate $R = 1.0204$ so that the rate of time preference, β is 0.98. Regarding the Frisch-labour elasticity, we use common parameter value borrowed from the literature, $\kappa = 1.5$. The preference parameter θ^G measures the degree of substitutability/complementarity between private and public goods in the household's utility function and which is usually agnostic, is set equal to 0.1 in the baseline calibration (Baxter and King, 1993). The habit persistence parameter b is set at 0.90.

Depreciation rates, private capital utilization, adjustment costs We set the value for the depreciation rates of private capital δ^H, δ^{NT}, in both sectors equal to 0.03. This is done so as to match the average value for the ratio of private investment as a share of GDP. Parameter ψ_1 and ψ_2 are calibrated such as the steady state capital utilization rate is equal to 1. We set the adjustment cost parameter for the risk-premium coefficient on net foreign asset position, ψ, equal to 0.002 which the minimum value for which stationarity is guaranteed. Private capital adjustment cost parameters v is set to 0.9.

Production of final and intermediate and goods The home bias parameter, ω^H, is set at 0.12 % so that along with the intratemporal elasticity of substitution between the domestic absorption of the home produced tradable good and the imported good, z^H being set equal to 1.5 will give imports of goods and services as a share of GDP around 41%, which is close to the value added reported in the data. In the model, exports and imports are value added while national accounts provide data on gross exports and imports which include intermediate goods. For this reason, we use data from OECD-TiVA accounts which provide data on the value added content of exports and imports. The parameter ω is calibrated at 0.46 such that the output in the non tradable sector as a share of total gross value added to be around 52% which is in accordance with the sectoral data from national accounts at NACE Rev.2 level.[16]

The capital share parameters, α^H and α^{NT}, in the production function of intermediate goods and in the non tradable sector respectively, are both set to 0.35 as is common in the literature. We set the share of domestic investment ω^F at 0.65, reflecting the relative larger contribution of domectic investment to total investment in the tradable sector. However this attributes a large portion to FDI investments in the private investment which goes along with data evidence on FDI transcactions (see United Nations Conference on Trade and Development (UNCTAD), 2023). Moreover, we set the elasticity of substitution between domestic and foreign investment α^F at 0.5 indicating that domestic and inward FDI are imperfect complements. Both values for ω^F and α^F are close to Clancy and Merola (2016). The elasticities of substitution among the different intermediate good varieties in the tradable good, ϵ^H, ϵ^{NT}, yield price markups equal to 1.14 (see also Papageorgiou and Vourvachaki, 2017 and Kouvavas *et al.*, 2021). The export elasticity, represented by parameter z^X is set at 2 which is the median value reported in Corbo and Osbat (2013). Finally, the exogenous TFP variables, A^H and A^{NT}, are normalized to unity.

Calvo parameters and price indexation We set the price stickiness parameters θ^H, θ^{NT}, in both sectors - tradable and non tradable, equal to 0.75. This means that firms adjust prices about every 4 quarters, which is the average duration of price adjustment for euro area firms. The indexation parameters of the intermediate good firms in the tradable and non tradable goods, λ^H, λ^{NT}, and imported goods sectors λ^F is set to 0.35 which is consistent with the fact that about one-third of companies in the euro area apply rules of thumb (for instance, changing prices by a fixed percentage, or following a CPI indexation rule) as reported in Fabiani *et al.* (2018).

Wage stickiness and employment shares We set the wage stickiness parameter θ^w equal to 0.5 (see Malley *et al.*, 2009, Angelini *et al.*, 2013) which assumes that the probability of wages to remain fixed of around 3-4 quarters. Following evidence from euro area countries The steady-state markup ϵ^w on private sector wages is set at 6 so that the private wage mark-up is at 1.2. The wage indexation parameter λ^W is set at 0.5 which roughly matches the 45%-50% of the workforce who are unionised, in the vast majority public sector workers, are covered by the CoLA system.[17] The employment shares in the tradable and non-tradable sector ϕ^H and ϕ^{NT} are set equal to 0.55 and 0.45 so that according to the data employment shares are higher in the services sector.

Fiscal policy parameters The steady-state values of fiscal and public finance policy instruments are set at their data averages. In particular, τ^C, τ^K, τ^L, τ^{PR} are the effective tax rates on consumption, capital, labor and payroll in the data over 2009–2019 (see Commission *et al.*, 2022) and are equal to 0.11, 0.17, 0.14 and 0.08 respectively. Moreover, $s^{G^C} \equiv \frac{G^C_t}{Y^{GDP}}$, $s^Z_t \equiv \frac{Z_t}{Y^{GDP}}$ namely, government spending on goods/services and on transfer payments, as shares of output, are set at their average values in the data, 0.25 and 0.04

[16]See Cyprus Statistical Authority, Gross Value Added by Economic Activity. We define as tradable sector the sum of agricultural, industry (excluding construction), and tourism related activities. Non tradable sector includes the remaining business sector activities

[17]Namely, the Cost of Living Allowance (CoLA), which uses the Consumer Price Index (CPI) as a benchmark for wage adjustments.

respectively. Finally, the risk-premium coefficient on public debt ψ^d is set at 0.01 so that 1% increase in the public debt to GDP ratio leads to an increase in the risk-premia by 4 basis points.

Cypriot public debt and its holders Regarding, λ^D, the fraction of total public debt held by foreign private agents is set at 0.2 while the fraction of total public debt held by EU institutions λ_t^{EU} is set at 0.6 which are the average value in the data (see Eurostat accounts on Structure of Government debt) during 2009–2019.

Table 5: Baseline parameter values and policy variable

Parameter	Value	Description
β	0.98	Rate of time preference
δ^H, δ^{NT}	0.03, 0.03	Depreciation rate of capital in T and NT sector
κ	1.5	Inverse of Frisch labor elasticity
α^H, α^{NT}	0.35, 0.35	Capital share parameter in T and NT sector
ω^F	0.65	Domestic investment share
$\theta^H, \theta^{NT}, \theta^F$	0.75, 0,75, 0.35	Price stickiness parameter in T, NT and imported sector
θ^W	0.5	Wage stickiness parameter
θ^G	0.1	Degree of substitutability between private and public goods
b	0.90	Habit persistence parameter
μ^w	2.25	EoS between sectoral hours worked
z	2.17	EoS between composite final T and NT goods
z^H	1.5	EoS between home and foreign-produced T goods
α^F	0.5	EoS between domestic and foreign investment
z^x	2	EoS between exported goods
ϵ^w	6	Wage mark-up parameter
$\epsilon^H, \epsilon^{NT}, \epsilon^F$	8,8.2,11	Price mark-up parameters in T, NT and imported T goods
v	0.9	Adjustment cost parameter on physical capital
$\mathcal{D}$	0	Threshold parameter of Public Debt as Share of Output
ψ	0.002	Risk-premium on net foreign asset position
ψ^d	0.01	Risk premium on public debt
ϕ^H, ϕ^{NT}	0.55, 0.45	Share of employment in the T, NT sector
ω	0.46	Fraction of final tradable goods used in the production of final good
ω^H	0.12	Home bias parameter
$\lambda^W, \lambda^F, \lambda^H, \lambda^{NT}$	0.5, 0.35, 0.35, 0.35	Wage and sectoral price indexation parameters
γ^F, γ^X	27.5,27.5	Adjustment cost parameter on imported goods and on composition of exported goods
A^H, A^{NT}	1	TFP in T, and NT sectors
$\rho^{\epsilon^{p,F}}, \rho^{y^*}, \rho^{FDI}$	0.15,0.25,0.1	Persistence parameters on shocks (imported goods prices, exports and inward FDI)

Table 6: Fiscal policy and other exogenous variables

Parameter	Value	Description
τ^C	0.11	consumption tax rate
τ^L	0.14	labour income tax rate
τ^{PR}	0.08	payroll tax rate
τ^K	0.17	capital income tax rate
s^{G^C}	0.25	current expenditures to GDP ratio
s^Z	0.04	other transfers to GDP ratio
s^{FDI}	0.06	inward FDI to GDP ratio
λ^D	0.2	share of public debt held by domestic private agents
λ_t^G	0.2	share of public debt held by foreign private agents
λ_t^{EU}	0.6	share of public debt held by EU institutions
R^{EU}	1.020	interest rate on EU institutions loans
R^*	1.016	exogenous world interest rate

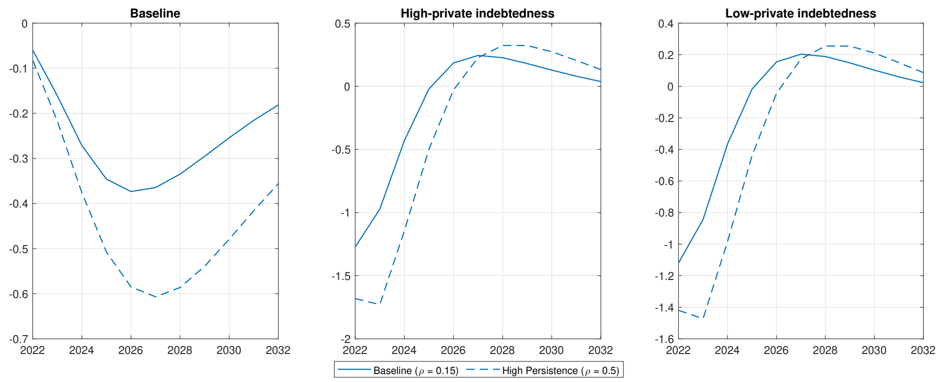
F Additional tables and figures

Table 7: Impact on output (average 2022-2026)

	S1	S2	S3	Total
Baseline model	-0.35	-1.16	-0.15	-1.66
Model with financial constraints $\left(\kappa = 0.23, \frac{F}{GDP} = 113\%\right)$	-1.02	-3.35	-0.67	-5.03
Model with financial constraints $\left(\kappa = 0.05, \frac{F}{GDP} = 25\%\right)$	-0.87	-2.66	-0.65	-4.18

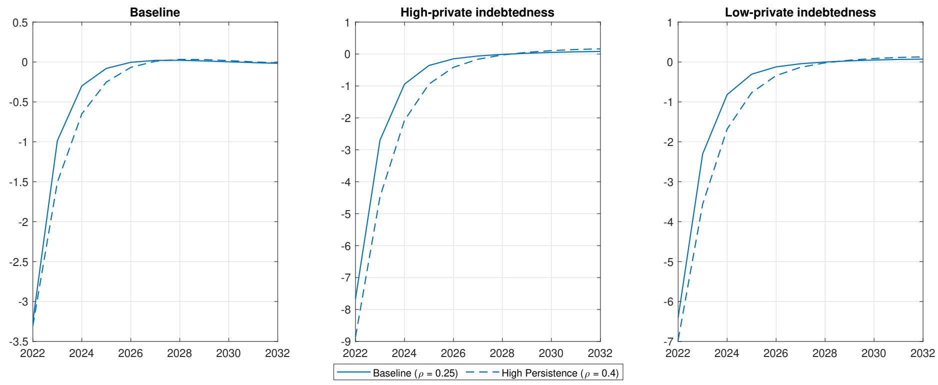
Note: Results are expressed in % deviations from the initial steady state

Figure 10: Impulse response functions: Output (S1)



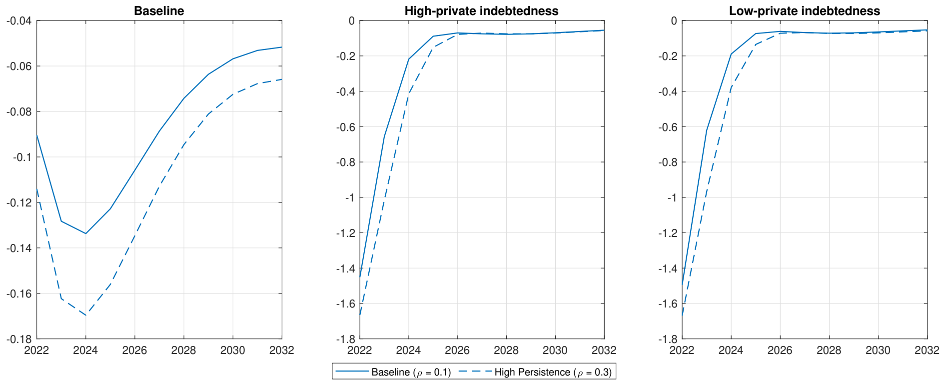
Note: Output is expressed in % deviations from the initial steady state.

Figure 11: Impulse response functions: Output (S2)



Note: Output is expressed in % deviations from the initial steady state.

Figure 12: Impulse response functions: Output (S3)



Note: Output is expressed in % deviations from the initial steady state.

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