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The Financial Resource Curse Revisited: The Supply-Side Effect of Low Interest Rates

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The Financial Resource Curse Revisited:

The Supply-Side Effect of Low Interest Rates

Simon Hildebrandt and Jochen Michaelis[1]

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Abstract

Benigno and Fornaro (2014) show that an episode of low interest rates may harm an economy. Low interest rates trigger a consumption boom, labor shifts away from the tradable sector, learning spillovers from foreign technology decline and so do domestic total factor productivity, consumption and welfare. In this paper, we show that their conclusion of a financial resource curse does not hold in a world with capital as production factor. Low interest rates now trigger an investment boom, there is no shift of labor between sectors, total factor productivity remains unaffected. Our model confirms "textbook wisdom", i.e., an episode of low interest rates enhances welfare in a small open economy.

JEL Classification: E22, F36, F43

Keywords: capital accumulation, endogenous growth, macroeconomic integration

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I. Introduction

Conventional economic wisdom states that a period of low interest rates is like a gift, it is welfare-improving. Benigno and Fornaro (2014) challenge this view by arguing that low interest rates trigger a consumption boom with welfare-reducing side effects. While the increase in tradable consumption goods is met by imports from abroad, the increase in non-tradable consumption goods leads to an increase in their production. As labor shifts away from the tradable sector, the tradable sector shrinks. But it is the tradable sector which serves as an engine for growth by importing foreign knowledge and technology. Consequently, the economy faces a slowdown of both productivity and consumption growth. With respect to welfare, the negative long-term side effect may outweigh the positive short-term consumption boom. Benigno and Fornaro (2014, henceforth BF) refer to peripheral Europe. In the wake and at the beginning of the European Monetary Union, Greece, Italy, Portugal and, in particular, Spain experienced a sharp decline in their interest rates followed by a subsequent decline in total factor productivity (OECD 2022a, b).

In this paper, we show that conventional economic wisdom is not that bad. BF do not model any supply-side effect, they neglect any adjustment of the firms' capital stock. We extend their framework to incorporate capital as production factor. Besides the tradable and non-tradable sector, we assume a capital goods sector producing investment goods that augment the capital stock. Our small open economy may also import investment goods from abroad. This slight modification of the technology assumption is sufficient to turn around the key result of BF: there is no financial resource curse. Because of the beneficial supply-side effects, the episode of low interest rates is indeed a gift.

The incorporation of capital as production factor is motivated by the empirical observations displayed in Figures 1 and 2. The interest rate spread of Greece, Italy, Portugal, and Spain against Germany declined even before the adoption of a single currency and the convergence process continued in the 2000s (see the blue lines). During the same period, the investment ratio rose substantially in all four countries (see orange lines in Figure 1). Spain is again most impressive with investments rising from 14% in 1994 to 23% of GDP in 2006. Figure 2 shows that all four countries were able to attract foreign firms to their country. The ratio of net inward foreign direct investments to GDP multiplied over the years; in Greece the ratio rose from about zero in the 1990s to 2% in 2006; in Italy the ratio increased from 0.3% in 1996 to 3% in 2006. Market integration was not restricted to consumption goods, but covered investment goods too.

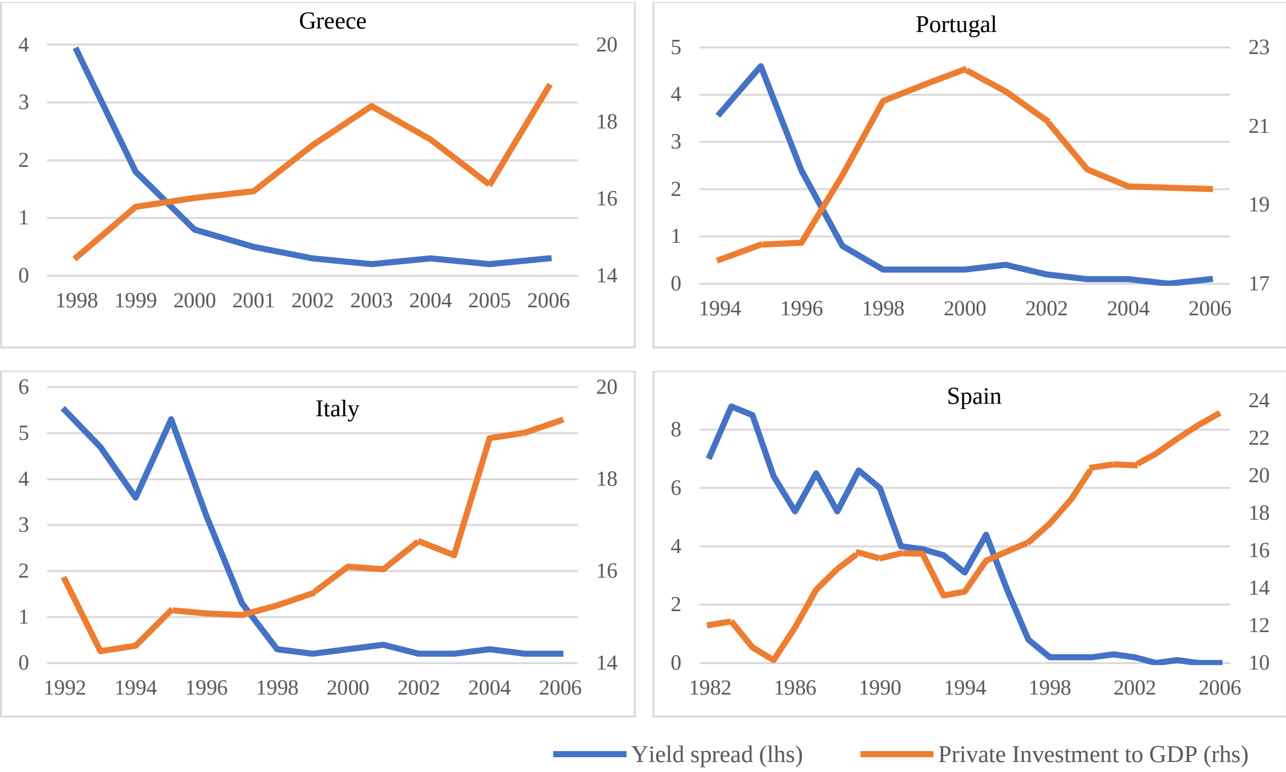

Figure 1: Yield spread of ten-year government bonds against Germany (lhs) and investment ratio (rhs). Source: IMF (2021), OECD (2022a), Sinn (2014); own calculations.

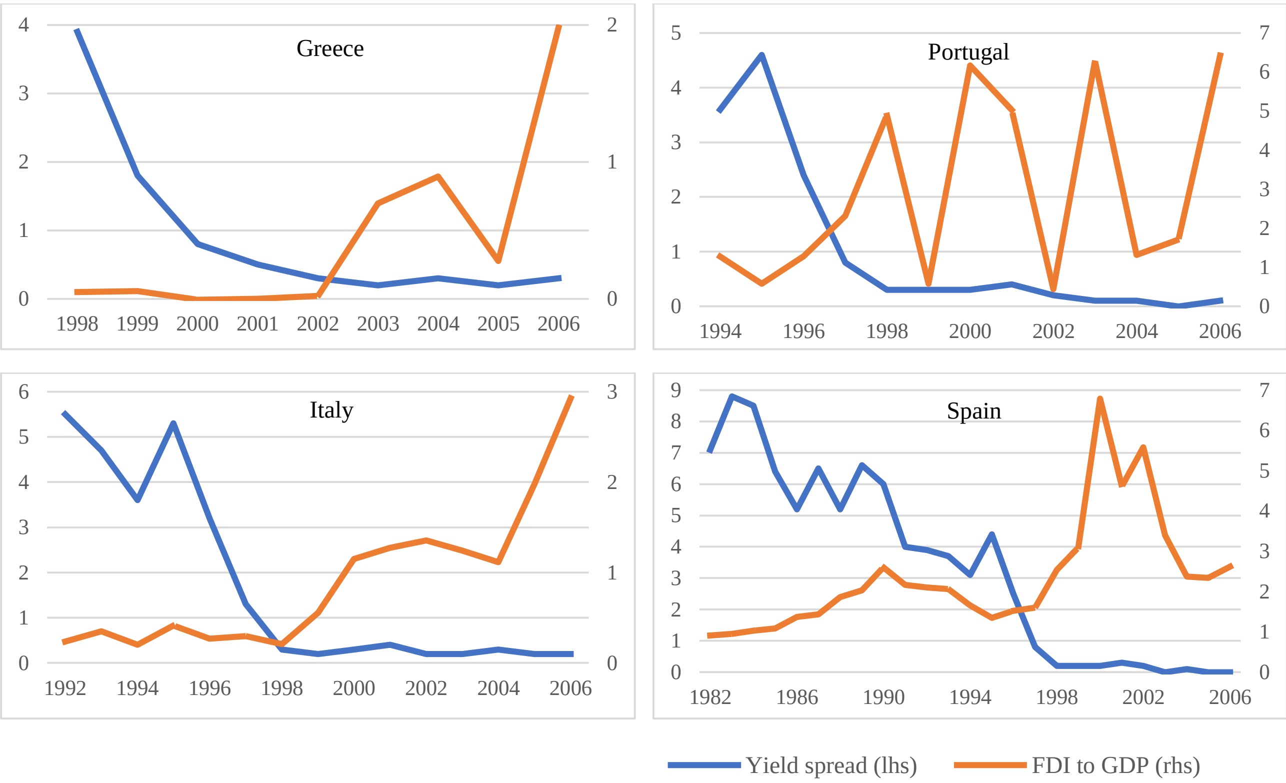

Figure 2: Yield spread of ten-year government bonds against Germany (lhs) and net inward FDI to GDP (rhs). Source: OECD (2022a), Worldbank (2022), Sinn (2014); own calculations.

From a theoretical point of view, we open an additional adjustment channel. Low interest rates generate a consumption boom, but now – as indicated by the data – they also generate an investment boom. The increase in demand and output of non-tradable goods no longer requires a shift of (labor) resources from the tradable to the non-tradable sector; the additional output will now be produced with the help of additional (imported) capital. There will be no shrinkage of the tradable sector, no negative impact on the accumulation of foreign knowledge, and no decline in the growth rate of total factor productivity, consumption, and welfare.

The remainder of the paper is organized as follows. Section II provides a brief overview of related literature. In Section III, we describe the model setup of our analysis. In Sections IV and V, we present the calibration of the model and the results of our numerical experiments. Section VI concludes.

II. Related literature

Benigno and Fornaro (2014) contribute to the literature on resource curses. As mentioned by Frankel (2010), it is striking how often countries with oil or other natural resource wealth have failed to grow more rapidly than those without. The literature on the Dutch disease by Corden and Neary (1982) provides a prominent explanation: the increase in the price of a natural resource leads to a resource export boom followed by an appreciation of the domestic currency, which in turn lowers non-resource exports (see Frankel (2010) and Venables (2016) for overviews). Using Norway and Australia as case studies, Bjørnland and Thorsrud (2016) emphasize that a booming resource sector may have substantial positive productivity spillovers on non-resource sectors.

Alberola and Benigno (2017) extend the three-sector (tradable, commodity, non-tradable) model of Corden and Neary (1982) by allowing for an open financial account and dynamic productivity gains as in BF. If the economy is a commodity exporter, an increase in (world) prices of the commodity good generates a positive wealth effect, the representative household gets richer, the household borrows from abroad to consume more. In addition, the interest rates decline since a country with a resource boom typically must pay lower risk premiums. Resources shift out of the tradable sector, the economy suffers from a negative productivity effect.

Benigno et al. (2020) argue for a global financial resource curse. The starting point is the observation that since the late 1990s the United States of America had experienced large capital inflows, mainly from Asian countries, and that the US economy subsequently faced a substantial decline in productivity growth. The capital inflows lead to a consumption boom in non-tradables and a contraction in economic activity in the tradable sector. Profits in the tradable sector drop, reducing the incentive to invest in innovations. The fall in innovation activities results in a slowdown of productivity growth of the world technological leader, which, given the BF assumption of learning spillovers, spreads to the rest of the world.

The BF framework rests very much on the assumption that the episode of capital inflows leads to a reallocation of sectoral resources. This assumption is empirically motivated in Benigno et al. (2015). Using data of 70 middle- and high-income countries from 1980 to 2015, they identify 155 episodes of large capital inflows and find that these episodes typically coincide with an economic boom. But once the episodes stop, recessions prevail. During the boom, resources, in particular labor, shift from tradable sectors (agriculture, manufacturing) to non-tradable sectors (e.g. services, construction). Moreover, the larger the shift, the larger the fall in aggregate output and total factor productivity in the aftermath of the episode. Sinn (2014) also emphasizes the reallocation of sectoral resources.

The link between structural change and productivity growth is analyzed in McMillan and Rodrik (2011). When labor and other resources move from low- to high-productivity sectors, overall productivity rises. This pattern was observed in China, India and other Asian countries in the 1990s and the early 2000s. The integration into world markets (globalization) has expanded high-productivity jobs, labor moved into these jobs, the structural change was productivity-enhancing. In other cases (Latin America and Sub-Saharan Africa), however, the process of globalization produced many losers. Many firms in the manufacturing sector were not able to meet the standards of the world market, they went bankrupt, workers moved in the "wrong direction" (McMillan and Rodrik, 2011, p. 2) from more productive to less productive activities. In these countries, the structural change has caused factor productivity and economic growth to decrease.

In a seminal paper, Rodrik (2013) shows that unconditional convergence in labor productivity indeed exists. But it is restricted to labor productivity in the manufacturing sector; it does not hold for economy-wide labor productivity. His data covers 118 countries over a timespan from 1965 to 2005, each country enters with around 20 manufacturing industries (two-digit level). The estimated convergence rate of 2.9 percent per year is surprisingly large, suggesting that the speed of convergence is high, or equivalently, the gap to the technological leader will be substantially reduced quite quickly. Since non-manufacturing sectors do not exhibit convergence, and since these sectors contribute more than 60 percent of production, the convergence result does not carry over to the level of the economy. Kinfemichael and Morshed (2019) challenge this result and find evidence of unconditional convergence in both labor productivity in the service sector and aggregate labor productivity.

Labor is the main subject of investigation in almost all studies mentioned so far. These studies say little about capital as a factor of production and they all block out repercussions from the process of capital accumulation. As this paper will show, this is a serious shortcoming. A noteworthy exception is de Cordoba and Kehoe (2000). Taking Spain's 1986 entry into the European Union as example, they model a capital poor economy, which opens itself to its capital rich neighbors. Capital inflows set in, there is a consumption and, for our line of argument most importantly, an investment boom. The increase in the capital stock shifts the production possibility frontier outwards. Concerning capital accumulation, our modeling approach borrows heavily from de Cordoba and Kehoe (2000).

III. The basic model

Our framework builds on the small open economy model of Benigno and Fornaro (2014), which we augment by incorporating capital as factor of production. Firms produce three types of goods, tradable (T) and non-tradable (N) consumption goods, and capital goods (K). The small open economy is fully integrated in world markets.

Households

The economy is populated by a continuum of identical households with population size normalized to unity. The representative household maximizes the utility function

$$U_t = \sum_{t=0}^{\infty} \beta^t log C_t, \tag{1}$$

where β is the discount factor, and C_t is a consumption index defined as

$$C_t = (C_t^T)^{\omega}(C_t^N)^{1-\omega}. \tag{2}$$

Here, C_t^T and C_t^N are consumption of tradable and non-tradable goods, respectively. Parameter ω is the expenditure share of the tradable good. Due to (1) and (2), and in accordance with BF, the elasticity of substitution between the two available types of goods as well as the intertemporal elasticity of substitution between goods across periods is restricted to unity. The household supplies labor inelastically without loss of utility.

The budget constraint of the representative household reads:

$$C_t^T + P_t^N C_t^N + \frac{as_{t+1}}{R_t} = W_t L + as_t + \pi_t^T + \pi_t^N + \pi_t^K, \tag{3}$$

where

$$as_{t+1} = B_{t+1} + q_t K_{t+1}^{TD} + q_t K_{t+1}^{ND}. \tag{4}$$

The tradable good serves as numeraire, the price is given by the world market and normalized to unity, P_t^N is the relative price of non-tradable goods in terms of the tradable good, and L is the endowment of labor, which receives the wage rate W_t. We normalize labor endowment to unity, $L = 1$. To simplify, we do not allow for outward foreign direct investment. Domestic firms are wholly owned by domestic households, profits from firms in the tradable sector T, π_t^T, the non-tradable sector N, π_t^N, and the capital goods sector K, π_t^K, go to the representative household.

The domestic (D) household accumulates assets in three forms, bonds B_{t+1}, capital invested in sector T, K_{t+1}^{TD}, and capital invested in sector N, K_{t+1}^{ND}. All assets purchased in period t are priced at $1/R_t$, and redeemed in period $t+1$. The price of a capital good in terms of the tradable good, q_t, and the gross interest rate, R_t, are given by the world market. Capital goods purchased in period t must be put in place one period before they are used, i.e., these goods turn into capital for production in the subsequent period $t+1$.

The representative household chooses C_t^T, C_t^N and as_{t+1} to maximize utility function (1) subject to the budget constraint (3). From the solution of this problem, we get the demand function for non-tradable goods,

$$C_t^N = \frac{1-\omega}{\omega} \frac{1}{P_t^N} C_t^T, \tag{5}$$

and

$$C_{t+1}^T = \beta R_t C_t^T, \tag{6}$$

as standard Euler equation for the optimal intertemporal allocation of tradable consumption goods.

Firms

Tradable sector. Firms in the tradable sector combine L_t^T workers with K_t^T units of real capital to produce output Y_t^T. The technology is Cobb-Douglas with constant returns to scale:

$$Y_t^T = A_t (L_t^T)^{\alpha} (K_t^T)^{1-\alpha}, \tag{7}$$

where the stock of technology, A_t, is a total factor productivity shifter. As emphasized by BF, the assumption on the endogenous process of technology accumulation is key for their results:

$$A_{t+1} = A_t \left[1 + c L_t^T \left(1 - \frac{A_t}{A_t^*}\right)\right]. \tag{8}$$

There is a world technological leader, whose stock of technology, A_t^*, grows with exogenous rate, g^*. The domestic economy is well behind, $A_t < A_t^*$, but is catching up. The speed of convergence is determined by the scale parameter *c*, and in particular, employment in the tradable sector. Because of international competition, the tradable sector absorbs foreign technology (see Rodrik, 2013; Duarte and Restuccia, 2010; and Blanchard and Giavazzi, 2002). For a more detailed motivation of (8), we refer to BF.[2]

Sector T firms import capital goods from the rest of the world (foreign), K_t^{TF}. Domestic and foreign capital goods are perfect substitutes in production:

$$K_t^T = K_t^{TD} + K_t^{TF}. \tag{9}$$

Capital depreciates with the rate δ, so the capital stocks follow $K_{t+1}^{TD} = (1-\delta)K_t^{TD} + I_t^{TD}$ and $K_{t+1}^{TF} = (1-\delta)K_t^{TF} + I_t^{TF}$, where I_t^{TD} is investment produced by the domestic capital goods sector, and I_t^{TF} are capital goods imported from abroad.

To maximize profits, firms in sector T set the marginal product of labor equal to the wage:

$$W_t = MPL_t^T = \alpha A_t (L_t^T)^{\alpha-1}(K_t^T)^{1-\alpha}. \tag{10}$$

In period $t-1$, firms decide on the capital stocks K_t^{TD} and K_t^{TF} for production in period t:

$$MPK_t^{TD} + (1-\delta)q_t = R_{t-1}q_{t-1}, \tag{11}$$

$$MPK_t^{TF} = MPK_t^{TD}. \tag{12}$$

Firms act on behalf of the representative household who is the owner of the firms. From the household point of view, bonds and capital invested in sectors T and N are perfect substitutes (see Eq. (4), so the rate of return must be equal. In period $t-1$, capital goods cost q_{t-1}, the yield is the additional output in period t (marginal product of capital MPK) plus the value of the depreciated capital good at the end of period t, $(1-\delta)q_t$. Investment of q_{t-1} in a bond yields gross return $R_{t-1}q_{t-1}$, embodying opportunity costs (Funke and Strulik, 2000). Firms can import capital goods from abroad, Eq. (12) is the no-arbitrage condition.

[2] In our model, we stick to assumption (8). However, given the empirical evidence (see, e.g., Bijsterbosch and Kolasa, 2010; Lee and Chang, 2009; Girma, 2005; Chamarbagwala et al., 2000; Eaton and Kortum, 2001), we suppose that the inflow of FDI and/or multinationals constitute a more direct and thus superior mechanism to absorb foreign technology. Hildebrandt (2022) investigates the impact of this mechanism in a more detailed manner.

Non-tradable sector. The output of the non-tradable good, Y_t^N, is produced with labor, L_t^N, and capital, K_t^N. Again, the technology is Cobb-Douglas:

$$Y_t^N = (L_t^N)^{\alpha}(K_t^N)^{1-\alpha}. \tag{13}$$

In accordance with BF, total factor productivity is fixed to unity, in the non-tradable sector there is no absorption of foreign technology, there is no technological progress.

As in Eq. (9), we assume domestic and foreign capital goods as perfect substitutes:

$$K_t^N = K_t^{ND} + K_t^{NF}. \tag{14}$$

Capital stocks follow $K_{t+1}^{ND} = (1-\delta)K_t^{ND} + I_t^{ND}$ and $K_{t+1}^{NF} = (1-\delta)K_t^{NF} + I_t^{NF}$, where investment I_t^{ND} is produced by the domestic capital goods sector, and investment I_t^{NF} is imported from abroad.

The firms' first-order conditions for labor and capital are:

$$W_t = P_t^N \cdot MPL_t^N = P_t^N \cdot \alpha(L_t^N)^{\alpha-1}(K_t^N)^{1-\alpha}, \tag{15}$$

$$P_t^N \cdot MPK_t^{ND} + (1-\delta)q_t = R_{t-1}q_{t-1}, \tag{16}$$

$$MPK_t^{NF} = MPK_t^{ND}. \tag{17}$$

Because of perfect labor mobility across sectors, firms in the non-tradable sector must pay the same wage as firms in the tradable sector. The interpretation of Eqs. (16) and (17) is in line with Eqs. (11) and (12).

By combining the optimality conditions and making use of $K_t^D = K_t^{TD} + K_t^{ND}$ and $K_t^F = K_t^{TF} + K_t^{NF}$, we also get

$$\frac{K_t^T}{L_t^T} = \frac{K_t^N}{L_t^N} \tag{18}$$

$$P_t^N = A_t. \tag{19}$$

Eq. (18) states that capital stocks per worker are identical across sectors. Eq. (19) describes the well-known Samuelson-Balassa effect. Productivity growth in the tradable sector promotes labor demand in sector T, the wage rate goes up, sector N faces an increase in the marginal costs of production leading to an increase in the relative price of non-tradable goods.

Employment in sector T and sector N add up to labor endowment:

$$L_t^T + L_t^N = 1. \tag{20}$$

Inserting this equilibrium condition for the labor market into (18) yields

$$L_t^T = \frac{K_t^T}{K_t^T + K_t^N}. \tag{21}$$

As capital stocks K_t^T and K_t^N are set in period $t-1$, the right-hand side of Eq. (21) and thus employment L_t^T is already fixed in period $t-1$. The profit-maximizing condition (10) then delivers the period t wage rate. It is important to keep this sequence in mind when discussing the impulse response function of an interest rate reduction in Section V.

Capital goods sector. The modeling of the domestic capital goods sector closely follows de Cordoba and Kehoe (2000), who assume that capital goods are produced using the tradable good and the non-tradable good as inputs. The technology is Cobb-Douglas:

$$I_t^D = (A_t)^{\mu}(Z_t^T)^{\gamma}(Z_t^N)^{1-\gamma}, \tag{22}$$

where I_t^D is domestic output of capital goods, Z_t^T and Z_t^N are the inputs of the tradable and non-tradable good, respectively. As de Cordoba and Kehoe (2000) mention, these inputs can be thought of loosely as equipment and structures. Sectors T and K produce physically tangible goods in an industrial or manufacturing manner and both sectors are exposed to international competition. We thus assume that sector K also absorbs foreign technology, albeit to a lesser extent than firms in sector T, $0 < \mu < 1$. Maximizing the profit function $\pi_t^K = q_t I_t^D - Z_t^T - P_t^N Z_t^N$ with respect to the inputs leads to

$$\frac{Z_t^T}{Z_t^N} = \frac{\gamma}{1-\gamma} P_t^N. \tag{23}$$

Because of the Samuelson-Balassa effect, the relative price P_t^N increases period by period. Therefore, the non-tradable good as factor of production becomes more expensive period by period, and firms in sector K adjust the optimal production plan by switching from Z_t^N to Z_t^T, the ratio Z_t^T/Z_t^N rises continuously.

Equilibrium

Our economy consists of two final goods markets (tradables and non-tradables) and two factor markets (labor and capital goods). A general equilibrium requires that all markets are simultaneously in equilibrium.

As stated in Eq. (20), the labor market is in equilibrium when labor supply by households (labor endowment) equals labor demand of firms from sector T and sector N. The capital goods market is in equilibrium when domestic output of capital goods equals demand for domestically produced capital goods of firms from sector T and sector N:

$$I_t^D = I_t^{TD} + I_t^{ND} = K_{t+1}^D - (1-\delta)K_t^D. \tag{24}$$

The market clearing condition for the non-tradable good,

$$C_t^N + Z_t^N = Y_t^N, \tag{25}$$

states that non-tradable output is consumed by the household and used as input for production of capital goods.

Making use of Eq. (4), Eq. (25) and firms' profit functions, the household budget constraint (3) delivers the market clearing condition for the tradable good:

$$C_t^T + \frac{B_{t+1}}{R_t} - B_t = Y_t^T - Z_t^T - q_t I_t^F + \frac{q_t K_{t+1}^F}{R_t} - q_{t-1}K_t^F, \tag{26}$$

where $I_t^F = I_t^{TF} + I_t^{NF}$ is (payment for) the import of foreign capital goods, $q_t K_{t+1}^F / R_t$ is the firms' borrowing of funds from abroad in period t, and $q_{t-1}K_t^F$ is the repayment of funds raised in period $t-1$.

In a next step, let us turn to the current account of the economy under consideration. A country's current account is defined as the change in its net foreign assets, $CA_t = NFA_t - NFA_{t-1}$. The value of the bonds acquired by the representative household in period t is B_{t+1}/R_t, the value of the funds raised by firms is equal to $q_t K_{t+1}^F / R_t$, thus we get $NFA_t = B_{t+1}/R_t - q_t K_{t+1}^F / R_t$. Backdating yields $NFA_{t-1} = B_t / R_{t-1} - q_{t-1} K_t^F / R_{t-1}$. Now the market clearing condition for the tradable good (26) can be rearranged to get the current account:

$$CA_t = Y_t^T - Z_t^T - C_t^T - q_t I_t^F + \frac{B_t - q_{t-1}K_t^F}{R_{t-1}}(R_{t-1} - 1). \tag{27}$$

The period t current account is given by net exports, $Y_t^T - Z_t^T - C_t^T - q_t I_t^F$, plus the interest earned on net foreign assets acquired in period $t-1$.

The intertemporal resource constraint

$$\sum_{s=t}^{\infty} Q_{t,s} CA_s = -\frac{B_t - q_{t-1}K_t^F}{R_{t-1}} \tag{28}$$

with

$$Q_{t,s} = \frac{1}{\Pi_{v=t+1}^{s} R_{v-1}} \tag{29}$$

has the familiar interpretation: the present value of the economy's resource transfers to (from) foreigners must equal the value of the economy's initial debt to (claims against) them. Note that we are interested in a temporary change in the world interest rate. To rule out arbitrage possibilities, intertemporal prices must adjust. This is captured by the market discount factor $Q_{t,s}$ describing the relative price of period s consumption in terms of period t consumption. $Q_{t,t}$ is interpreted as one, $Q_{t,t+1} = \frac{1}{R_t}$, $Q_{t,t+2} = \frac{1}{R_t}\frac{1}{R_{t+1}}$ and so on (see Obstfeld and Rogoff, 1996).

IV. Calibration

Our numerical exercise aims to give a rough estimation of the quantitative importance of the supply-side effects of a temporary reduction in the world interest rate. To facilitate the comparison with the results of BF, we closely follow their parametrization and use their values whenever possible. Concerning capital accumulation, the parametrization borrows from de Cordoba and Kehoe (2000). Note that both BF and de Cordoba and Kehoe (2000) parametrize their model to match some key data for Spain in the 1990s. To be clear, our analysis is not motivated by the aim to improve the fit of the model with Spanish data. Instead, we are interested in the question, whether, for reasonable parameter constellations, the supply-side effect of a temporary interest rate reduction is large enough to (over)compensate the financial resource curse effect emphasized by BF.

The home country is a small open economy with perfect access to international goods and capital markets. For that reason, the price of tradable goods is exogenously given and normalized to unity. Our economy can borrow and lend at the world gross interest rate, which in the benchmark scenario is assumed to be $R = 1.04$. The experiment is a temporary reduction in the world interest rate to 1 percent for ten years, after which the rate returns to 4 percent. In contrast to BF, our model allows for an international market for capital goods. The home country is assumed to be an importer of capital goods, the relative price of these goods is exogenously given by the world market and normalized to $q = 1$.

A cornerstone of the BF model is the process of technology accumulation (cf. Eq. (8)). The growth rate of the world technological frontier is set to $g^* = 0.015$. This number matches the average annual growth rate of total factor productivity in the United States of America between 1960 and 1995. The

Parameter	Value	Description
g^*	0.0150	Total factor productivity growth rate of the world technological leader
R	1.0400	Interest rate
R_low	1.0100	Interest rate in low interest rate scenario
q	1.0000	Relative price of capital goods
β	0.9760	Discount factor
ω	0.4140	Share of tradable goods in consumption
L	1.0000	Total endowment of labor
A_0^*	6.4405	Initial total factor productivity of the world technological leader
A_0	4.1384	Initial total factor productivity of the domestic economy
c	0.1670	Scale parameter in the process of technology accumulation
α	0.7011	Labor share in production of tradable goods and non-tradable goods
δ	0.0576	Capital stock depreciation rate
μ	0.4500	Degree of international technology spillover across sectors K and T
γ	0.3802	Share of tradable goods in capital goods production
K_0^T	1.0000	Initial capital stock in sector T
K_0^{TD}	0.5000	Initial domestic capital stock in sector T
K_0^{TF}	0.5000	Initial foreign capital stock in sector T
K_0^N	1.8400	Initial capital stock in sector N
K_0^{ND}	0.9200	Initial domestic capital stock in sector N
K_0^{NF}	0.9200	Initial foreign capital stock in sector N
B_0	0.0000	Initial bond holdings of the small open economy
T	225	Number of periods (years) to transit to steady state
t		Periods are years

Table 1: Calibration of numerical simulations

initial value for the technology stock of the technological leader is set at $A_0^* = 6.4405$, which corresponds to the estimation of Benhabib and Spiegel (2005) for the US in 1995. For the home country, the initial value is set to $A_0 = 4.1384$. The scale parameter capturing the ability of the home country to absorb foreign technology is set to $c = 0.167$. Let us turn to the production functions for the tradable and non-tradable goods. In line with BF, the labor share is assumed to be identical across sectors. We set $\alpha = 0.7011$, which is the average of the sectoral estimates of de Cordoba and Kehoe (2000). Following de Cordoba and Kehoe (2000), we put the rate of capital stock depreciation at $\delta = 0.0576$. For the capital stocks, a starting (period 0) value has to be defined. De Cordoba and Kehoe (2000) found initial capital stocks in non-tradable production 1.84 times higher than in tradable production. Accordingly, we assume $K_0^N = 1.84$ and $K_0^T = 1$. Moreover, we assume that the initial capital stocks are accumulated equally by domestically produced and imported capital goods, $K_0^{ND} = K_0^{NF} = 0.92$ and $K_0^{TD} = K_0^{TF} = 0.5$.

In a next step, we calibrate the capital goods production function (22). The exponent of tradable goods in the production function is $\gamma = 0.3802$, the parameter capturing the degree of international technology spillovers is set to $\mu = 0.45$. As our numerical experiments in Section V indicate, the parameter μ plays a decisive role, results are sensitive to variations in this parameter. In particular, the parameter must not exceed a critical threshold; a very high total factor productivity in sector K implies that domestic production of capital goods exceeds domestic demand for capital goods. The home country would become a (net) exporter of capital goods. Such a scenario is not meaningful in the context of a catching-up economy (Eaton and Kortum, 2001). For the first ten periods of simulation, we exclude this scenario by assumption. For details, we refer to Section V.

Calibrating parameters of the representative household, we again follow BF and choose the discount factor at $\beta = 0.976$. As the Euler equation (6) indicates, this assumption ensures that in the steady state the growth rate of consumption of tradable goods is equal to g^*. In the steady state, consumption of tradable goods grows at the same rate as the world technological leader. The expenditure share of the tradeable good is set to $\omega = 0.414$, the labor supply of the household (labor endowment) is normalized to $L = 1$.

Finally, we set initial bonds holdings to $B_0 = 0$. The transit to the steady state is assumed to last 225 periods (years). Table 1 summarizes our parametrization.

The experiment we study in Section V is a temporary reduction of the interest rate. We follow BF by investigating two interest rate scenarios: the "normal interest rate" scenario serves as benchmark, $R = 1.04$ is chosen as the interest rate for all 225 periods. In the "low interest rate" scenario, we choose $R = 1.01$ for the first ten periods, subsequently, the interest rate returns to $R = 1.04$.

V. Numerical results

In this section, we show how our economy responds to the temporary reduction in the world interest rate.[3] Figure 3 displays the transition process for the first 20 periods. Solid lines indicate the "normal interest rate" scenario, dashed lines show the "low interest rate" scenario. To facilitate the comparison with BF, we also present some of their key results at the bottom of Figure 3.

As emphasized by BF, the fall in the interest rate triggers a financial inflow to the home economy, home households boost consumption financed by borrowing from abroad. The consumption boom covers both tradable and non-tradable goods. In BF, the increase in demand for tradables leads to a rise in imports. To meet the increase in demand for non-tradables, production of non-tradables rises, which in turn requires a shift of labor from the tradable sector to the non-tradable sector. The rate of technology accumulation declines which constitutes the financial resource curse.

In a world with capital as production factor and an international integrated market for capital goods, the response to a temporary fall in the interest rate shows a different pattern. We confirm the consumption boom (Panels b and c), but we stress the supply-side effect. The increase in demand for tradable goods now leads to an increase in imported capital goods K_t^{TF}, firms in sector T use capital from abroad to expand production Y_t^T (Panels d and f). The same holds true for firms in sector N; they expand production Y_t^N by making use of imported capital goods K_t^{NF} (Panels e and g). The supply-side effect lowers the incentive to reallocate labor toward the non-tradable sector. Our technology assumptions put it to the extreme, i.e., there is no reallocation of labor across sectors. As capital stocks in both sectors benefit simultaneously from declining interest rates, L_t^T and L_t^N are unaffected by the fall in the interest rate (Panel h). Consequently, total factor productivity A_t is not negatively affected (Panel i), there is no financial resource curse.

The fall in the interest rate pushes demand for both domestically produced and imported capital goods. In the short run, however, only the world market can satisfy the additional demand for capital goods, K_t^F goes up substantially (see Panel k). The change in domestically produced capital goods

[3] Conducting our numerical simulations, we preserve the standard shooting algorithm provided by Benigno and Fornaro (2014) to solve the simultaneous system of equations. The shooting algorithm starts with an initial guess for tradable consumption C_0^T. Combining the guess with the start values of Table 1 allows us to solve for all endogenous variables and to check for the fulfilment of the intertemporal resource constraint (28). If (28) is not fulfilled for the initial C_0^T guess, the algorithm updates C_0^T. The algorithm stops doing so when the deviation from (28) falls short of a predefined tolerance parameter.

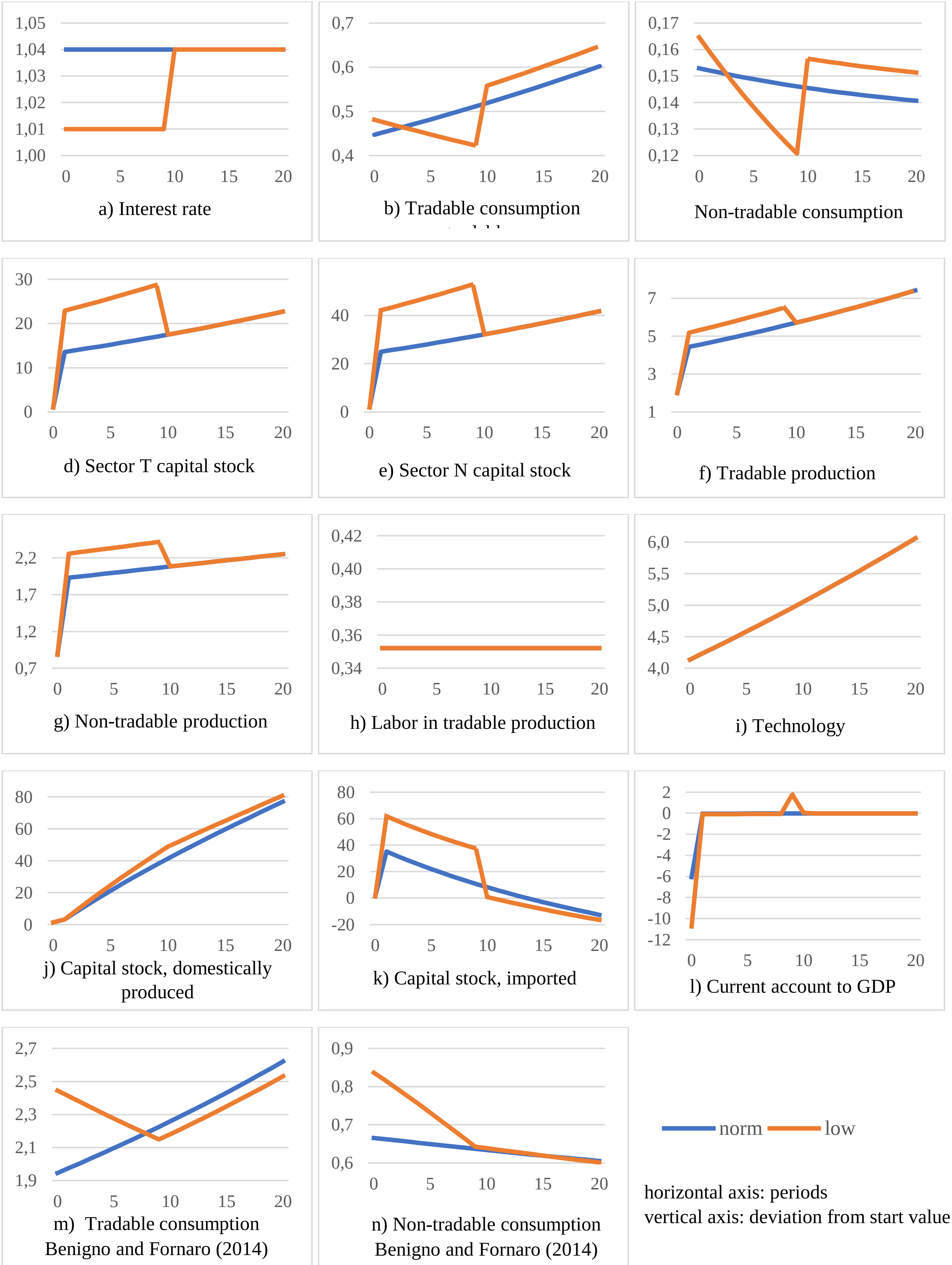

Figure 3: Results of numerical simulations

K_t^D is sluggish (Panel j), the production of these goods requires a shift of tradables and non-tradables toward sector K, where they serve as input factors.

A growing sector K implies that a growing fraction of the output of tradable and non-tradable goods is not available for consumption. This explains the decline of C_t^T and C_t^N during the period of low interest rates (Panel b and c). Note that there is a time interval, where the consumption of tradables and non-tradables in the low-interest scenario is lower than in the normal interest rate scenario. When low interest rates end, consumption levels are higher in the low than in the normal interest rate scenario. The positive impact on long-run consumption is the result of the increase in the domestically produced capital stock K_t^D. In the long-run equilibrium, the marginal product of capital and hence the capital stocks are identical across scenarios, thus a higher K_t^D implies a lower K_t^F. The home country imports less capital goods, home firms raise less funds from abroad, interest payments on net foreign debt decline, a larger fraction of resources can be used for home consumption. Higher long-run consumption explains higher welfare levels found for the low interest rate scenario (see below).

The current account CA_t (relative to GDP) shows a huge initial deficit reflecting the mentioned inflow of capital goods (Panel l). Such a huge initial current account deficit is also derived by BF, but in their model, the deficit is caused by a massive increase in the import of tradable consumption goods. Either way, to finance the imported goods the home economy takes out a loan generating net foreign debt. In the subsequent periods, interest payments on its net foreign debt cause (small) current account deficits. When the episode of low interest rates ends, foreign loans get more expensive, home firms demand less foreign capital goods, the current account is positive for just one period (see the period 10 dip in Panel l). The one-period current account surplus is not sufficient to make the net foreign position positive, thus home must make interest payments to foreign even from period 11 onwards.

Welfare

Benigno and Fornaro (2014) were motivated by their finding that, for plausible parameter constellations, the episode of low interest rates reduces welfare of the small open economy. Driving force is the decline in the rate of technology accumulation. As we have shown, the driving force is reduced (in our model: nullified) by the incorporation of capital as factor of production. Does this mean that the episode of low interest rates is always welfare-enhancing? This is not necessarily the case since the capital goods sector absorbs some output of both tradables and non-tradables. As already mentioned, these goods are not available for consumption and, ceteris paribus, lower welfare.

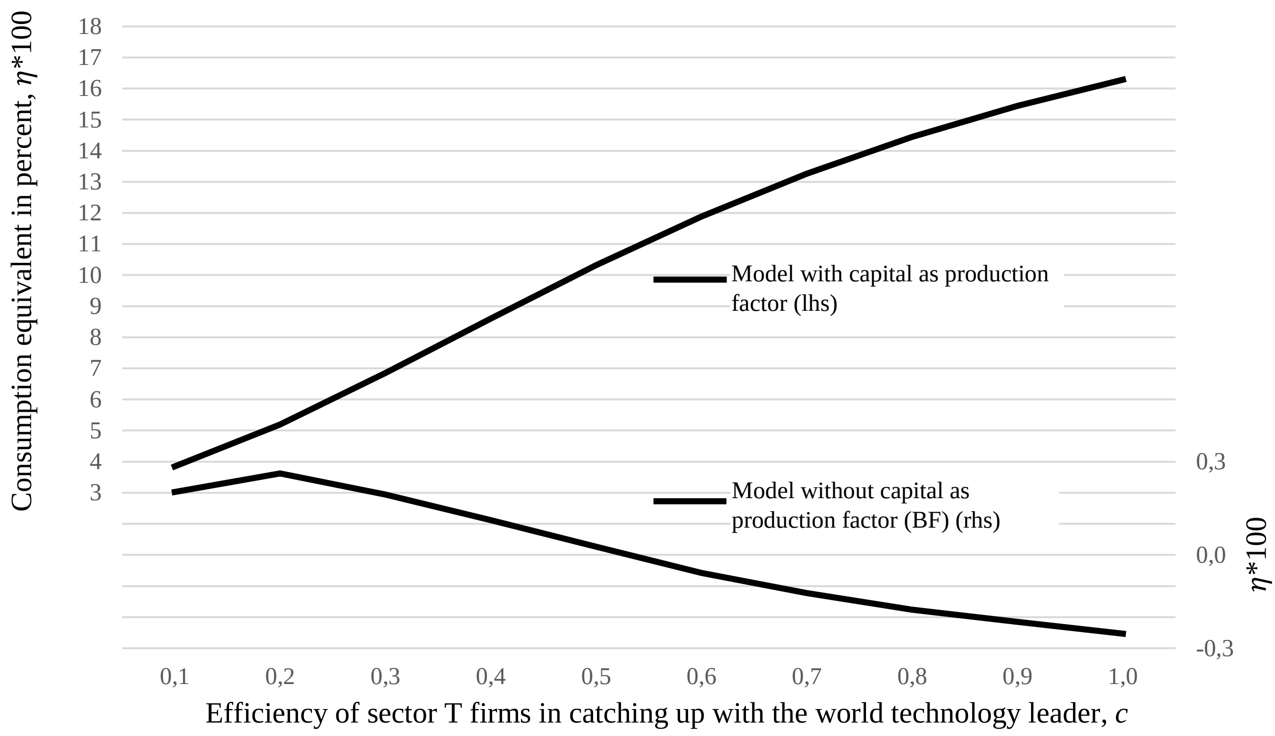

Figure 4: Consumption equivalent as function of c

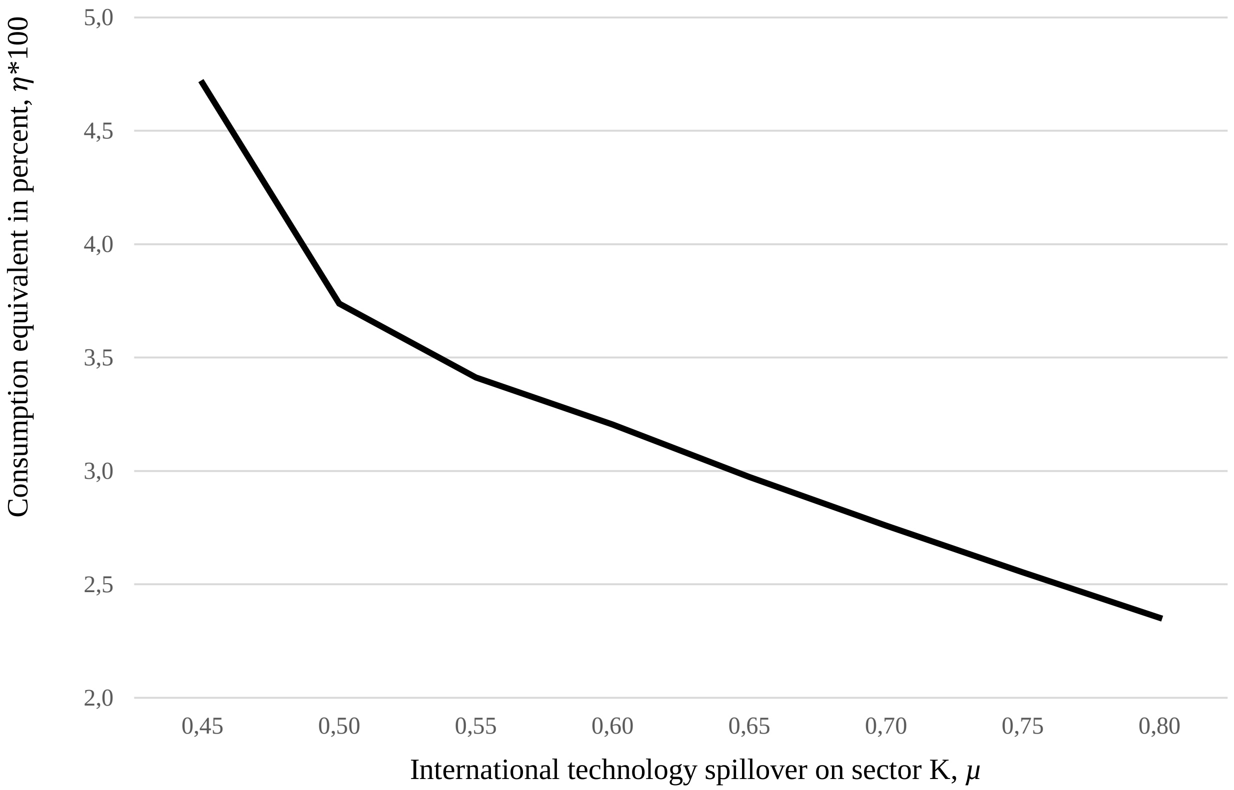

Figure 5: Consumption equivalent as function of μ

To sign the net welfare effect, we again borrow from BF and introduce the consumption equivalent η defined by

$$\sum_{t=0}^{\infty} \beta^t \log \left[(1+\eta)\, C_t^{norm} \right] = \sum_{t=0}^{\infty} \beta^t \log \left[C_t^{low} \right]. \tag{30}$$

The variable η measures the increase in consumption that the household must receive to be indifferent between staying in the normal interest rate scenario or moving to an economy with a period of low interest rates. For $\eta > 0$ ($\eta < 0$), the episode of low interest rates is welfare-enhancing (welfare-reducing).

Figure 4 illustrates sign and size of the consumption equivalent η as function of the learning parameter c. The parameter c captures the ability and efficiency of sector T firms to absorb foreign technology (see Eq. (8)). Two results are noteworthy. For the initial BF model, we confirm the BF conjecture of a financial resource curse. If c is sufficiently large, the consumption equivalent η is negative. In terms of welfare, the long-run decline in productivity and thus consumption exceeds the short-run consumption boom. Second, things are different in our model with capital as production factor. For all values of c, the consumption equivalent η is positive. Despite there being some periods where consumption in the low interest rate scenario is lower than in the normal interest rate scenario (sector K absorbs T and N goods), the overall welfare effect is positive. The temporary fall in the world interest rate and thus the period of cheap credits does not turn out to be a double-edged gift, but it is – in accordance with "textbook wisdom" – an improvement for the small open economy.

Figure 5 displays the consumption equivalent as function of μ, the parameter capturing the degree of international technology spillovers on the domestic capital goods sector K. The higher the spillovers, the lower the welfare gain. The explanation is simple. Total factor productivity in sector K is increasing in μ, domestically produced capital goods get more competitive, firms of sector T and sector N demand more capital goods from sector K, the output of sector K grows. But a growing sector K translates into a growing demand for tradables and non-tradables as input factors. Since the fraction of output, which is not available for consumption, is increasing in μ, the positive consumption and welfare effect of a temporary fall in the interest rates is decreasing in μ. Figure 5 also indicates that a meaningful model solution restricts the interval for μ. If μ exceeds a threshold (in our simulation 0,80), the home economy would become a net exporter of capital goods. On the other hand, if μ falls short of a threshold (in our simulation 0.45), the output of domestic capital goods would be not sufficient to balance depreciation of the capital stock K_t^D.

VI. Conclusion

In this paper, we show that an episode of low interest rates is not a bad but a good. From a textbook reader point of view, this is no surprise, but this view was challenged by Benigno and Fornaro (2014). These authors argue that lower interest rates slow down productivity growth. Because of a consumption boom, labor shifts away from the tradable goods sector, learning spillovers from abroad decline. Taking up the empirical finding that low interest rates also generate an investment boom, we extend the Benigno and Fornaro (2014) model to incorporate capital as production factor. In our framework, lower interest rates lead to higher imports of investment goods from abroad, the increase in the demand for non-tradable goods does not generate a shift of resources away from the tradable sector, there will be no slowdown of productivity growth and thus no financial resource curse.

If there is no (substantial) shift of labor away from the tradable sector, the ability to absorb foreign technology by learning-by-doing (parameter c) is of minor importance. From our point of view, a most promising line of research is the modeling of learning spillovers from inward foreign investments. Empirical evidence (see, for e.g., Chamarbagwala et al., 2000; and Rodrik, 2013) suggests that the import of investment goods from abroad is a particularly significant channel concerning the import of foreign technology. First results can be found in Hildebrandt (2022). He shows that the modeling of these positive supply-side effects of lower interest rates widens the scope for a financial resource gain.

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