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Revisiting the commodity curse: A financial perspective☆

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ABSTRACT

We study the response of a three-sector commodity-exporter small open economy to a commodity price boom. When the economy has access to international borrowing and lending, a *temporary* commodity price boom brings about the standard wealth effect that stimulates demand and has *long-run* implications on the sectoral allocation of labor. If dynamic productivity gains are concentrated in the traded good sector, the commodity boom crowds out the traded sector and delays convergence to the world technology frontier. Financial openness by stimulating current demand, amplifies the crowding out effect and may even lead to a growth trap, in which no resources are allocated to the traded sector. From a normative point of view, our analysis suggests that capital account management policies could be welfare improving in those circumstances.

1. Introduction

The commodity cycle starting at the turn of this century has reversed in the last years. The boom phase in commodity prices has contributed to boost growth and economic performance in resource rich economies, but the reversal has severely impacted their growth rates.[1]

Commodity prices are characterized by longer cycles (of around thirty years or supercycles, see — Erten and Ocampo (2013)) than overall business cycles. Since 1960 (IMF, 2015) two supercycles can be identified in the energy and food sectors: one from the mid-seventies to the end of the nineties and the current supercycle which peaked around 2010. The length of the commodity price cycles suggests that shocks in this sector are persistent but they might eventually reverse.

In this paper we re-examine the link between commodity booms and resource allocation by emphasizing the international financial dimension of this interaction. Our focus is in understanding how the access to international financial markets shapes the allocation of resources within an economy subject to commodity price cycles.

Indeed, the impact of commodity booms on resource rich economies has a long tradition in economic analysis. More precisely, the commodity resource curse or Dutch disease underscores the perverse impact that a positive commodity shock may have on the economy.

An increase in commodity prices represents a positive terms of trade shock that pushes up domestic relative prices and income. The increase in internal relative prices negatively affects the rest of the tradable sector and increases domestic demand, both of tradable and non-tradable goods. As a result, there is a reallocation of factors out of the tradable sector and into the commodity sector and the non-tradable sector. Corden and Neary (1982)

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[1] A recent study of the importance of commodity price fluctuations for emerging market economies is from Fernandez et al. (2015).

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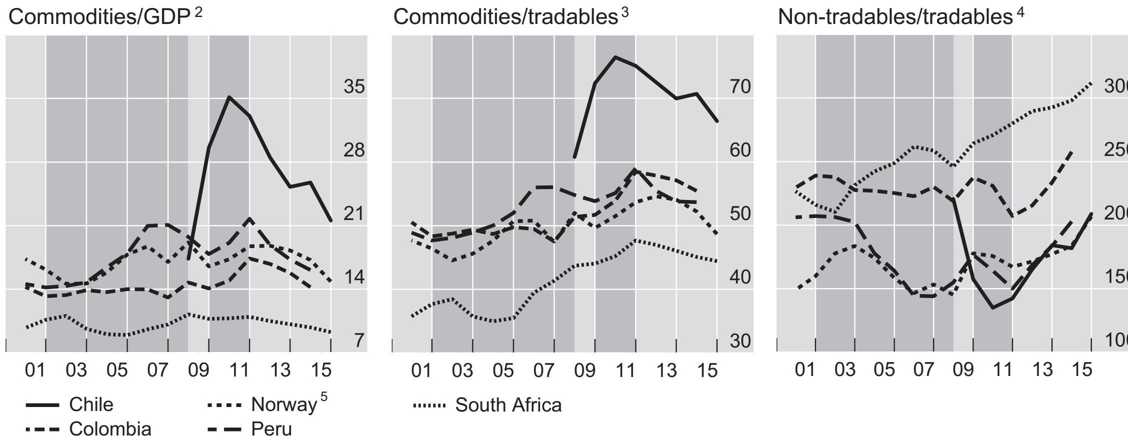
Relative weight of economic sectors[1]
In per cent



[1] Shaded area represents commodity boom periods. [2] Commodity sector includes agriculture and forestry, fishing, mining and quarrying and oil and gas extraction. All when applicable. [3] Tradable sector is the sum of commodity and manufacturing sectors. [4] Non-tradables include rest of economy which comprises mainly services: electricity, gas and water; construction and dwelling services, retail, accommodation, communication, transport, storage, courier services, financial services, business services, personal services, government, arts, health care services, defence, real estate. All when applicable. [5] GDP and sectorial GDP valued at basic prices.

Sources: National data; BIS calculations.

Fig. 1. Relative weight of economic sectors.

provided the seminal model to analyze this resource reallocation of factors and the process of de-industrialization in a simple framework.

The deeper meaning of the disease from the commodity booms is that they can also inhibit long term growth. However, absent some form of frictions, this relocation of resources would be entirely efficient and the Dutch disease wouldn't really constitute a "disease". The idea that the manufacturing sector is the driving force of the economy and that de-industrialization can lead to an impoverishment of the country is supported by the notion that resource-rich economies tend to show lower growth rates than economies endowed with few natural resources. For this to happen, there should be differential productivity dynamics among sectors and the sectoral reallocation induced by the commodity shock must hamper the ability to attain the productivity gains from technological development for the economy as a whole. This outcome hinges on two assumptions: i) faster productivity growth in the tradable sector relative to the other sectors of the economy and ii) the presence of (stronger) externalities in the tradable sectors.[2]

The perception that commodity booms can generate a misallocation of resources that impinges negative on growth is well entrenched and has been present in policy debates in commodity rich economies during the ascending phase of the cycle and, more intensely, when the cycle has reversed.

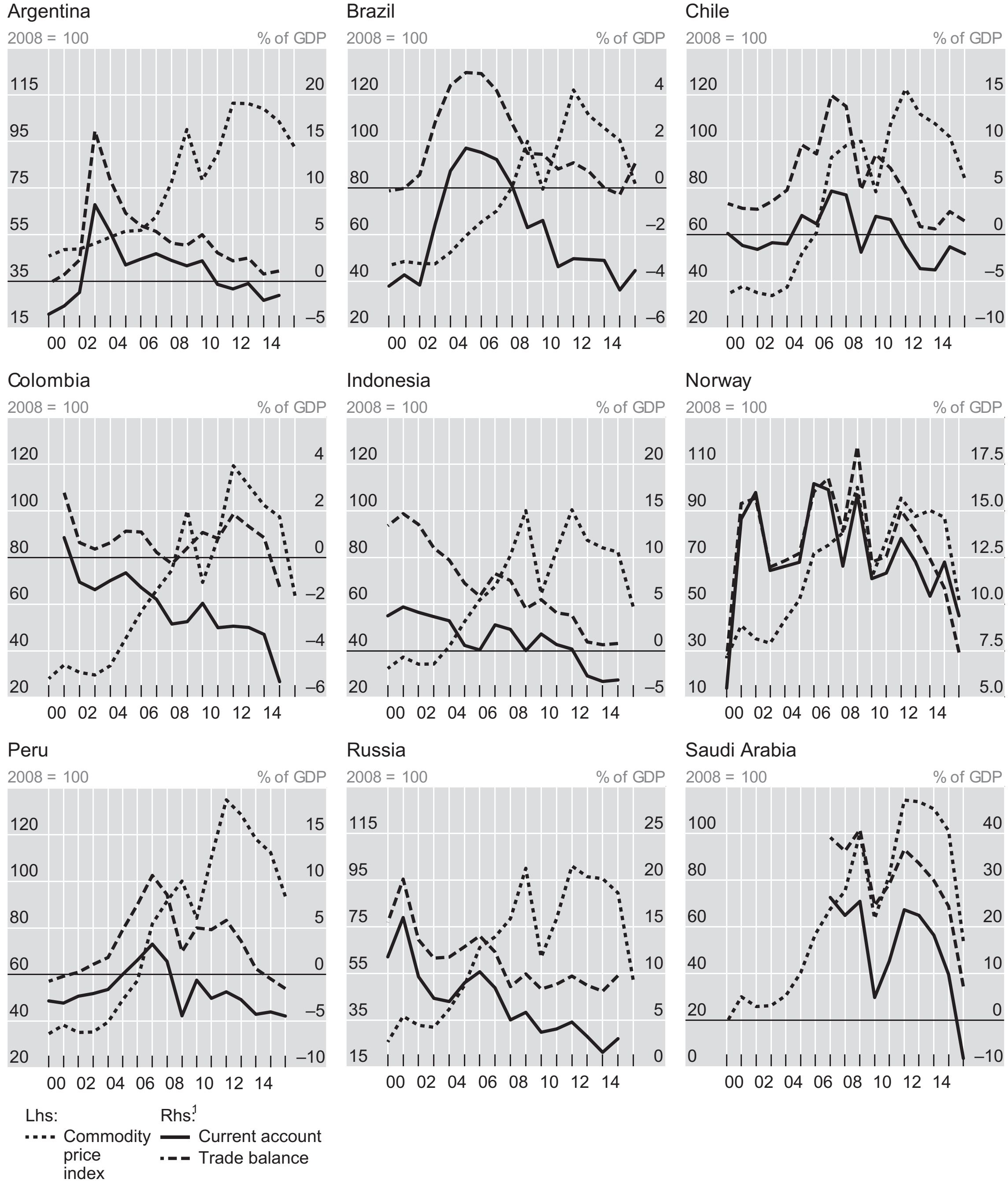
Fig. 1 shows the evolution of sectoral ratios since 2000 for a subset of commodity exporters (shaded areas represent periods of high commodity prices). While the share of the commodity sector relative to total GDP and the rest of the tradable sector increases during the boom period, the ratio of non-traded goods over tradeable suggests a decrease in the relative importance of the traded sector following the recent decline in commodity price.[3]

While the reference model of Corden and Neary (1982) assumes a financially closed economy (i.e. trade balance is always in equilibrium), the dynamics of external accounts have gathered less attention in the academic literature on commodity shocks. In practice, the concern about the fallout of the commodity cycles has been increased by the evolution of external positions in commodity exporters, which is displayed in Fig. 2.

In a financially open economy, after a positive commodity shock, the exports of tradeable are expected to decline and a higher overall domestic demand of tradeable can be satisfied by higher imports. The trade and current account balances impact is, in principle, undefined as the worsening of the tradable balance could be more than

[2] The most widespread intuition to explain this outcome is that a large share of the tradable goods is manufactures, which tend to enjoy higher productivity growth, as they are more prone to convey technological progress than other sectors. As a result, a commodity price boom may reduce the ability to grasp the productivity gains from technology and depresses long-term growth. Theoretically, this result is built into models through the introduction of dynamic productivity gains (by spillover, or by a learning-by-doing effect or increasing returns to scale) in the tradable sector of the economy.

[3] However, the evidence on Dutch disease is mixed (see IMF (2015), box 2.1 for a survey), both on the sectoral reallocation and on long-term growth inhibition. Older studies (Spatafora and Warner (1995), Bjørnland (1998) find no evidence of a reduction in manufacturing following the commodity boom, and the latter actually finds that sector benefited in Norway from oil discoveries and high prices. More recent evidence, using more disaggregated data (Ismail (2010) tends to find more support for the reallocation hypothesis. Regarding long term growth, the evidence is elusive, too (see the survey by Magud and Sosa (2013)).



[1] End of year cumulative sum of current account and trade balance as shares of end of year cumulative GDP.

Sources: FAO; IMF, *Balance of Payments Statistics and Primary Commodity Prices*; UN Comtrade database; World Bank; Bloomberg; Datastream; national data; BIS calculations.

Fig. 2. Current account, trade balance and the commodity price index.

offset by the expected large improvement in the commodity balance. The actual profile of the external balances – see Fig. 2 – is an inverted U-shaped: an initial improvement followed by a deterioration of the trade and current account balances, as the increased domestic demand and the reduction in tradable exports dent the initial boost coming from commodity exports.)

In terms of the financial account this means that, on impact, the country improves its net debtor position and experiments capital outflows. Furthermore, if the initial debtor position is in foreign currency, the increase in domestic relative prices would reduce external debt. These two factors would reduce the perception of risk and facilitate financing and, as a matter of fact, a negative correlation between terms of trade and risk premia exists (see IMF (2015)). But the relaxing of the financing constraint facilitates the turnaround of the current account to the point that commodity booms can lead to external imbalances even before its peak, which is the case of several countries in our sample. These facts underscore the potential relevance of the external financing channels to analyze the impact of commodity booms in the economy.

In this paper, we develop a model of the commodity curse and explore the financial channels to study the interaction between commodity cycles and access to international financial markets. We take as starting point the three-sector (traded, commodity and nontraded) financially-closed economy model of Corden and Neary (1982) and we introduce two main extensions: we allow for open financial account to examine a first financial channel through the capacity to save or borrow from abroad and the role of net foreign asset position; second we allow for dynamic productivity gains in the traded sector as in Benigno and Fornaro (2014) to assess possible long-run consequences on growth and its interaction with international financial markets.

We first focus on the economy in which there are no dynamic productivity gains and study the impact of a temporary commodity price shock. The first result is that, independently of the financial structure, there is a possibility for complete de-industrialization (during the commodity boom) of the traded sector as long as its technology displays constant return to scale. This result depends on the fact that the shock could potentially affect the comparative advantage that an economy has in the production of the traded good relative to the commodity good. Secondly we show that under financial account openness, a commodity boom leads to an (initial) accumulation of net foreign assets that results in a permanent shift of resources out of the traded sector. This comes about through the standard wealth effect that arises in a bond only small open economy.[4] When we introduce dynamic productivity gains into the traded sector, a commodity boom crowds out the traded sector and delays convergence to the world technology frontier. Financial openness by stimulating current demand, amplifies this crowding out effect. Finally, there is a possibility that the commodity boom can lead to a growth trap in which no resources are allocated to the traded sector and the economy does not grow.

We then study the welfare implications of commodity price boom in the context of our model economy. In the simplest case in which there are no dynamic productivity gains, a commodity price boom is always welfare improving. On the other hand in the presence of growth externalities, we show how an increase in commodity prices can be welfare reducing as the economy shifts resources, during the boom, out of the traded sector where the productivity gains are concentrated. Moreover during a commodity boom under open financial account can be more costly from a welfare point of view relative to the financial autarky case. Since agents do not internalize the effects of the growth externalities, the wealth effect coming from higher commodity prices, induces them to borrow to consume more, an effect that further shifts resources out of the traded good sector.

1.1. Related literature

This paper is related to several strands of literature. First, our paper is related to the literature on the “Dutch disease” by Corden and Neary (1982) which is the reference work within this strand of literature. We borrow their structure but we focus on temporary shocks emphasizing the role of international financial markets in the transmission of commodity price shocks. Krugman (1987) introduces positive growth externalities in the manufacturing sector: his paper shows how comparative advantage evolves over time when a learning-by-doing externality is introduced, leading to dynamic economies of scale. In this case, the shift in country's comparative advantage from the manufacturing sector to the production of natural resources will entail a problem when eventually, the natural resource will run out and the lost manufacturing sector will not come back.[5] We also adopt a similar structure in which the traded sector is the source of dynamic productivity gains. Van der Ploeg and Venables (2013) study the effects of a windfall of foreign exchange in a two-sector small open economy, focusing, as we do, here on the issue of structural change that occurs following a temporary windfall. While we share the same insight in terms of the role of financial openness and its long-run implication, our three-sector economy allows us to study how the evolution of relative comparative advantage between the traded and commodity sectors interacts with the structure of international financial market and the presence of dynamic productivity gains.[6]

Another strand of literature studies the business cycle and policy implications of commodity price fluctuations. García-Cicco and Kawamura (2015) develop a rich small open economy model with financial frictions, a learning by doing externality and a fraction of non-Ricardian (credit constraint) consumers. Their focus is mainly normative and they assess the relative merits of rules for government expenditures, capital controls and taxes on domestic lending. Hevia and Nicolini (2015) on the other hand study the optimal monetary and exchange rate policies in small open economy with price and wage rigidities subject to oil price shocks. Similarly, Catao and Chang (2015) analyze the optimal monetary policy response to changes in world food prices in a framework in which food plays a distinctive role in the utility functions. Bergholt (2014) uses a rich model applied to the Norwegian economy to study the conduct of optimal monetary policy for an oil exporting economy in which the oil sector affects the rest of the economy through the supply chain channel. This channel is modeled by considering the case in which producing oil requires intermediate home goods produced in the manufacturing and the service sector. He finds that this supply chain channel does not alter the standard monetary policy prescriptions.

While we share some of the features of these papers, our focus is more on the medium-run fluctuations and less on short run policy stabilization issues.

A third strand of literature studies the interaction between commodity price fluctuations and the optimal resource extraction problem: recently Hamann et al. (2015) propose an interesting model to study the impact of permanent commodity price fluctuations on monetary policy for a small open economy along those lines by combining both short-run and long-run aspects of commodity price fluctuations. Finally, our paper is also related to Benigno and Fornaro (2014) who study how financial market shocks influence the allocation of resources between traded and

[4] We thank Martin Uribe for stressing this point. We acknowledge here that the wealth effect is a well known result in a bond only small open economy. To the best of our knowledge, we are not aware of studies that have emphasized its implication for resource allocation and the possibility that it might lead to a complete de-industrialization in the long-run as we discussed in the paper.

[5] In Krugman (1987) there is no explicit consideration given to the oil sector, but the increased inflow of foreign currency that follows natural resource discoveries is approximated with a direct transfer payment from the foreign country to the home country.

[6] Their framework is richer in other dimensions from which we are abstracting. They consider the role of physical capital accumulation and differences in capital intensities and capital mobility between sectors. They emphasize the role of imperfection in explaining the adjustment towards the new steady state following commodity windfall. In our case the dynamic of the adjustment towards the new steady state depends on the possibility that comparative advantage influences how resources are allocated during the commodity price change.

non-traded sectors: our framework here is more general as we consider explicitly the role of the commodity sector and the allocation of resources in a three-sector economy and also because we study the possibility that the economy might face the possibility of full de-industrialization. Moreover, this paper focuses on the role of the structure of financial markets to study the adjustment following a commodity price shock.

2. Model

We first start from a model that borrows its structure from the original paper by Corden and Neary (1982). The framework that we adopt is one of a three-sector small open economy that produces two goods (that we interpret as a commodity good and a consumption good) which are traded at an exogenously given world prices and a third non-traded goods, the price of which equalizes domestic demand and supply. We allow for few but key differences with respect to Corden and Neary (1982): first, on the external side we are going to study a financially open economy, in which there are trade imbalances and the current account can be different from zero.[7] Secondly, we assume that the presence of dynamic productive externalities in production is present in the traded sector as in previous contributions by Van Wijnbergen (1984) and Krugman (1987).[8] Finally, the characterization of the commodity good is such that the commodity good is produced using labor as variable input, serves as inputs in the other production processes but it is not directly consumed.

We consider a perfect foresight infinite-horizon small open economy so that in our analysis we can focus on two possible international financial asset market structures: one in which there is no trade in assets (financial autarky) and another one in which agents can trade in a real risk free asset.[9] Time is discrete and indexed by t. The economy is populated by a continuum of mass 1 of identical households and by a large number of firms operating in the three sectors.

2.1. Households

The representative household derives utility from consumption and supplies inelastically L units of labor each period. The household's lifetime utility is given by

$$U = \sum_{t=0}^{\infty} \beta^t u(C_t). \tag{1}$$

In this expression, $\beta < 1$ is the subjective discount factor and C_t denotes the consumption of a composite good. C_t is defined as a CES aggregator of tradable C_t^T and non-tradable C_t^N consumption goods. We assume that the period utility function is isoelastic:

$$u\left(C_t^j\right) \equiv \frac{1}{1-\rho}\left(C_t^j\right)^{1-\rho}.$$

The consumption basket, C_t, is a CES aggregate of tradable and nontradable goods

$$C_t \equiv \left[\omega^{\frac{1}{\kappa}}\left(C_t^T\right)^{\frac{\kappa-1}{\kappa}} + (1-\omega)^{\frac{1}{\kappa}}\left(C_t^N\right)^{\frac{\kappa-1}{\kappa}}\right]^{\frac{\kappa}{\kappa-1}}. \tag{2}$$

where $0 < \omega < 1$ denotes the share of expenditure in consumption that the household assigns to the tradable good and κ is the elasticity of intratemporal substitution between traded and non-traded goods.

The budget constraint of the household is

$$C_t^T + P_t^N C_t^N + \frac{B_{t+1}}{R_t} = W_t L + B_t + \Pi_t^O + \Pi_t^N + \Pi_t^T. \tag{3}$$

The budget constraint is expressed in units of the tradable good, whose price is constant and normalized to 1. The left-hand side represents the household's expenditure. We define P_t^N as the relative price of the non-tradable good in terms of the tradable good, so $C_t^T + P_t^N C_t^N$ is the household's consumption expenditure expressed in units of the tradable good. B_{t+1} is the stock of one-period risk-free bonds purchased by the household at price $1/R_t$. R_t is the gross world interest rate, which is exogenous from the perspective of the small open economy.

The right-hand side represents the income of the household. We denote with W_t the wage rate, and so $W_t L$ is the labor income received by the household. B_t is the gross return on the stock of bonds purchased by the household at time $t-1$. Finally, domestic firms in all sectors are wholly owned by domestic households and Π_t^j (with $j = O, N, T$) denotes the profits received from firms' ownership by the representative household.

Each period the representative household chooses C_t^T, C_t^N and B_{t+1} to maximize utility Eq. (1) subject to the budget constraint (3). The first order conditions of this problem are:

$$C_T : (C_t)^{-\rho}\left(\frac{C_t^T}{C_t}\right)^{-\frac{1}{\kappa}}(\omega)^{\frac{1}{\kappa}} = \mu_t, \tag{4}$$

$$C_N : (C_t)^{-\rho}\left(\frac{C_t^N}{C_t}\right)^{-\frac{1}{\kappa}}(1-\omega)^{\frac{1}{\kappa}} = \mu_t P_t^N, \tag{5}$$

$$B_{t+1} : \mu_t = \beta R_t \mu_{t+1} \tag{6}$$

where μ_t denotes the Lagrange multiplier associated with the budget constraint, i.e. the household's marginal utility of wealth. By combining the optimality conditions (4) and (5), we obtain the standard intratemporal equilibrium condition that links the relative price of non-tradable goods to the marginal rate of substitution between tradable and non-tradable goods:

$$\frac{(1-\omega)^{\frac{1}{\kappa}}\left(C_t^N\right)^{-\frac{1}{\kappa}}}{\omega^{\frac{1}{\kappa}}\left(C_t^T\right)^{-\frac{1}{\kappa}}} = P_t^N. \tag{7}$$

According to this expression, P_t^N is increasing in C_t^T and decreasing in C_t^N. In what follows we will use P_t^N as a proxy for the real exchange rate.

The last first order condition (6) is the standard Euler equation which determines the intertemporal allocation of tradable consumption between a generic period t and the subsequent period $t+1$.

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[7] Corden and Neary (1982) consider an economy that is subject to permanent shocks so that the current account is balanced. In our analysis, the case of financial autarky coincides with the analysis of Corden and Neary (1982).

[8] In particular, as in Torvik (2001) we also allow for the general case in which there are dynamic productive externalities and learning spillovers across all sectors.

[9] In the robustness section, we allow also for the case in which, under financial openness, the interest rate, at which the small open economy borrows, is debt-elastic.

2.2. Firms

Firms operate in three sectors: one sector produces the tradable good, one produces the commodity good (oil) and the other one produces the non-tradable good. This structure resembles Corden and Neary (1982) and Hamann et al. (2015) in which the commodity goods are used as an input in the production process of the traded and non-traded goods.

2.2.1. Tradable sector

In the tradable sector there are a large number of firms that produce using labor L_t^T, the commodity good $M^{O,T}$ and the stock of knowledge A_t, according to the production function

$$Y_t^T = \left(A_t^T L_t^T\right)^{\alpha^T} (M^{O,T})^{1-\alpha^T}, \tag{8}$$

where Y_t^T is the amount of tradable goods produced in period t.

The stock of knowledge is non-rival and non-excludable and so it can be freely used by firms producing tradable goods. Hence, profits can then be written as

$$\Pi_t^T = Y_t^T - W_t L_t^T - P_t^O M_t^{O,T},$$

where W_t denotes the wage rate in units of traded goods and P_t^O is the relative price of the commodity good. Profit maximization implies that

$$\alpha^T \frac{Y_t^T}{L_t^T} = W_t \tag{9}$$

$$(1-\alpha^T)\frac{Y_t^T}{M_t^{O,T}} = P_t^O. \tag{10}$$

These expressions say that at the optimum firms equalize the marginal profit from an increase in its variable input, the left-hand side of the expression, to its marginal cost, the right-hand side. We note that by combining Eqs. (9) and (10), we obtain:

$$1 = \frac{(W_t)^{\alpha^T}\left(P_t^O\right)^{1-\alpha^T}}{A_t^T(\alpha^T)^{\alpha^T}(1-\alpha^T)^{1-\alpha^T}}, \tag{11}$$

that defines the real marginal cost for the traded sector. From this expression we can see that the real wage is going to be determined by the evolution of the stock of knowledge and the relative price of the commodity good which in our case are both exogenously given.

2.2.2. Non-tradable sector

There is a representative firm producing a homogeneous non-traded good in a perfectly competitive environment. The firm chooses two inputs, labor and a commodity good, according to the production function

$$Y_t^N = \left(A_t^N L^N\right)^{\alpha^N} (M^{O,N})^{1-\alpha^N}. \tag{12}$$

Y_t^N denotes the output of the non-tradable good, A_t^N is total factor productivity specific to the non-traded sector, L_t^N is the amount of labor employed by firms in the non-tradable sector and $M^{O,N}$ is the amount of commodity used in the production of the non-traded good. Profits[10] in the non-tradable sector are

$$\Pi_t^N = P_t^N Y_t^N - W_t L_t^N - P_t^O M_t^{O,N}.$$

Profit maximization implies that

$$\alpha^N \frac{P_t^N Y_t^N}{L_t^N} = W_t \tag{13}$$

$$(1-\alpha^N)\frac{P_t^N Y_t^N}{M_t^{O,N}} = P_t^O. \tag{14}$$

By combining Eqs. (13) and (14) we obtain:

$$P_t^N = \frac{(W_t)^{\alpha^N}\left(P_t^O\right)^{1-\alpha^N}}{A_t^N(\alpha^N)^{\alpha^N}(1-\alpha^N)^{1-\alpha^N}}. \tag{15}$$

From the expression of the marginal cost in the traded and non-traded sectors, Eqs. (11) and (15) respectively, we note that the relative price P_t^N are affected by commodity price fluctuations when labor shares (α^T and α^N) differ between the two sectors. Indeed, when $\alpha^N = \alpha^T$ the real exchange rate will be determined by supply side only and will be a function of relative productivity in the traded and non-traded sectors.

2.2.3. Commodity sector

The commodity sector produces under a decreasing return to scale technology using just labor as a variable input according to the following production function:

$$Y_t^O = A_t^O\left(L_t^O\right)^{\alpha^O}. \tag{16}$$

Y_t^O denotes the output of the commodity good, A_t^O is total factor productivity specific to the commodity sector and L_t^O denotes the amount of labor employed by firms in the commodity sector. In this setting the price of the commodity good is taken as given and firms maximize profits defined as:

$$\Pi_t^O = P_t^O Y_t^O - W_t L_t^O.$$

Profit maximization implies

$$\alpha^O \frac{P_t^O Y_t^O}{L_t^O} = W_t. \tag{17}$$

From this expression we note that an increase in the price of the commodity good leads to an increase in the demand of the labor for a given wage. We will refer to this effect as the resource movement effect (as in Corden and Neary, 1982) as mobile resources (in this case labor) are directed towards the commodity sector.

[10] With constant return to scale and perfect competition, profits are zero in equilibrium.

2.3. Knowledge accumulation

One of the key feature of our small open economy is the endogenous process of knowledge accumulation. In our baseline case we allow for the stock of knowledge to evolve endogenously only in the traded sector.[11]

In particular, the stock of knowledge available to firms in the tradable sector evolves according to

$$A_{t+1}^T = A_t^T\left(1 + c^{TT}L_t^T\left(1 - \frac{A_t^T}{A_t^*}\right)\right), \tag{18}$$

where $c^{TT} > 0$ is a parameter determining the impact of the sectoral labor allocation on productivity growth, and A_t^* denotes the stock of knowledge of the world technological leader, which grows at the constant rate g^*.[12,13]

This specification is similar to the one adopted in Benigno and Fornaro (2014) in which the stock of knowledge in a generic period t depends not only on the past knowledge, but also on the amount of labor employed in the tradable sector. The more the amount of labor that is allocated towards the traded sector the faster the convergence towards the world technology frontier. As in Nelson and Phelps (1966) and Benhabib and Spiegel (2005), this formulation captures the idea that human capital contributes to the absorption of foreign knowledge. Secondly, under this specification in which dynamic productivity gains arise only in the traded sector, the source of convergence in productivity is given by the traded sector, in the spirit of the empirical findings of Duarte and Restuccia (2010) and Rodrik (2013).

Moreover, the allocation of labor across the three sectors also influences the transition towards the steady state. In particular, in the numerical simulations we will consider the case of a country that starts below its steady-state proximity to the frontier. In this case, during the transition to the steady state the stock of knowledge of the economy grows at a rate higher than the one of the world technological frontier.

As mentioned above, we assume that knowledge is a non-rival and non-excludable good. This assumption, combined with the presence of a large number of firms in the tradable sector, implies that firms in the traded sector, do not internalize the impact of their actions on the evolution of the economy's stock of knowledge. This is a typical growth externality: firms do not internalize the value of allocating labor to the traded sector, because they don't consider the impact of their actions on the growth rate of productivity in the traded sector. This is a feature of the most influential endogenous growth models (as in Romer (1986, 1990) and Aghion and Howitt (1992)).

In terms of production structure there are three assumptions in our baseline framework. We first assume that there is faster productivity growth in the tradable sectors compared to the other sectors (non-tradable and commodity sectors). Secondly, in our baseline case, we allow for the traded sector to be the only sector that experiences dynamic productivity gains and finally we rule out any spillover from productivity gains in the traded sectors to other sectors in the economy and vice versa. Benigno and Fornaro (2014) provide a discussion on the empirical evidence that underpins our first two assumptions. To summarize, there is a substantial body of literature that supports the idea that faster productivity growth arises in the traded sector compared to other sectors of the economy for both advanced and emerging market economies.[14]

Secondly, cross-country knowledge spillovers have a key role in the context of the growth literature (Grossman and Helpman, 1991; Parente and Prescott, 1994; Santacreu, 2015): the empirical evidence suggests that the traded sector benefits more from these spillovers.[15] Moreover, there is a body of literature that emphasizes the role of trade in facilitating the transmission of knowledge and productivity growth across countries. The empirical analysis of Coe et al. (1997) and Amiti and Konings (2007) emphasizes the role of imports while Blalock and Gertler (2004), Park et al. (2010), Van Biesebroeck (2005) in China, and by Manjón et al. (2013) in Spain, for micro evidence focus on the role of exports.

Finally, in our baseline case, we rule any technology spillovers from the traded sector to the other sectors of the economy. While there are some evidence that a booming energy sector has spillover effects on the non-oil sector (see Bjørnland and Thorsrud, 2016 for the case of Norway) we focus first on the simpler structure to highlight the mechanism and later discuss the effects of spillovers among sectors.

2.4. Market clearing and competitive equilibrium

Market clearing for the non-tradable good requires that the amount consumed is equal to the amount produced:

$$C_t^N = Y_t^N. \tag{19}$$

Combining Eq. (19), with the households' budget constraint (3), the equations for firms' profits and the equilibrium condition $\Pi_t = \Pi_t^T + \Pi_t^N + \Pi_t^O$, we obtain the market clearing condition for the tradable good:

$$CA_t = \frac{B_{t+1} - B_t}{R_t} = Y_t^T - C_t^T + P_t^O\left(Y_t^O - M_t^{O,T} - M_t^{O,N}\right) + B_t(1 - 1/R_t). \tag{20}$$

Here we note that when the commodity good is not used as an input in the production process of traded and non-traded goods, its only possible use is to be exported. On the other hand, when it is used as an input in the production process, it might happen that depending on its price, it might be optimal for the country to import the commodity good and not producing it. Eq. (20) represents the current account (CA) equation for our small open economy. The current account is given by net exports, $Y_t^T - C_t^T$, plus net interest payments on the stock of net foreign assets owned by the country at the start

[11] In the robustness analysis we will allow for the stock of knowledge to evolve endogenously in the three sectors depending on the amount of labor employed in each sector and we will also consider the possibility that there will be spillovers transmitted from one sector to the others.

[12] The assumption of an exogenous world technological frontier means that our small open economy is too small to have an impact on the evolution of the world's stock of knowledge.

[13] In what follows, we denote with $a_t = A_t/A_t^*$ the proximity of the country to the world technological frontier.

[14] Indeed, using data from OECD countries during the period 1970–1985, De Gregorio et al. (1994) find that TFP grows faster in the tradable good sector relative to the non-tradable sectors while Duarte and Restuccia (2010) reach the same conclusion, using data from both OECD and emerging economies, for the period 1956–2004.

[15] Rodrik (2013) considers cross-country convergence in productivity at the industry level and finds that this is present only in manufactures, which may the bulk of the tradable sector. Similarly, Duarte and Restuccia (2010) find that convergence in productivity takes place in agriculture and manufacturing, but not in services.

of the period, $B_t(1-1/R_t)$ plus the trade balance for the commodity sector, $P_t^O\left(Y_t^O - M_t^{O,T} - M_t^{O,N}\right)$.

Finally, in equilibrium labor supply by households must equal labor demand from firms

$$L = L_t^T + L_t^N + L^O. \tag{21}$$

2.5. Dynamic equilibrium conditions and balanced growth path

The equilibrium conditions that define the dynamic equilibrium of the model for the case of financial account openness are given by the following set of equations: (note that the price of commodity is exogenous to the small open economy). From the household optimization problem, we obtain the Euler equation and the intratemporal allocation of consumption between traded and non-traded goods.

$$P_{t+1}C_{t+1}^{\rho} = \beta R_t P_t C_t^{\rho} \tag{22}$$

$$P_t^N = \frac{(1-\omega)^{\frac{1}{\kappa}}\left(C_t^N\right)^{-\frac{1}{\kappa}}}{\omega^{\frac{1}{\kappa}}\left(C_t^T\right)^{-\frac{1}{\kappa}}}. \tag{23}$$

We then have from the tradeable firms' problem Eqs. (9) and (10), from the non-tradeable firms' problem Eqs. (13) and (14), while Eq. (10) will be the relevant first order condition from the commodity sector. The system is then closed by the market clearing conditions (20), (19) and (21) along with the law of motion for technologies Eqs. (25), (27), and (26). and the three technology constraints (the production functions). We are now ready to define a perfect-foresight equilibrium as a set of processes C_t^T, C_t^N, P_t^N, B_{t+1}, Y_t^T, L_t^T, $M^{N,T}$, $M^{O,T}$, Y_t^N, L_t^N, $M^{T,N}$, $M^{O,N}$, Y_t^O, L_t^O, $M^{T,O}$, $M^{N,O}$, W, $A_{t+1}^T, A_{t+1}^N, A_{t+1}^O$ satisfying the previous set of equation for given exogenous processes $\left\{R_t, A_t^*, P_t^O\right\}_{t=0}^{\infty}$ and initial conditions B_0 and A_0^T, A_0^N, A_0^O.

The equilibrium under financial autarky replaces the current account Eq. (20) with the balanced trade condition in which

$$CA_t = 0 \Longrightarrow C_t^T = Y_t^T + P_t^O\left(Y_t^O - M_t^{O,T} - M_t^{O,N}\right).$$

Under financial autarky (and zero initial net foreign asset position) the value of consumption of the traded goods and the value of the commodity input used in the production processes are equalized to the value of traded and commodity outputs. The key difference is that under financial autarky, the real interest rate (the intertemporal price of consumption) is endogenously determined. This characterization of financial market would be the one that is implicitly adopted in Corden and Neary (1982). Moreover, we note that the case of financial autarky will allow us to implicitly analyze the possibility of permanent shocks: indeed when there is a permanent shift in our exogenous states, consumption will immediately adjust to the new steady sate value without any changes in the net foreign asset position.

3. Revisiting the commodity resource curse

In this section we consider an episode in which commodity prices increase temporarily: in particular, we assume that the price of commodity goods increases by 50% for 10 years and then returns to its initial value. This experiment is meant to capture in a simple stylized way long-lasting swings in commodity prices.

Our experiment is different from the exercise conducted in Corden and Neary (1982): they focus on comparative static analysis in which they study a permanent change in commodity prices or equivalently permanent shift in the technology in that sector. Motivated by historical evidence on long-lasting swings in commodity prices (see IMF (2015)), here we examine temporary changes rather than permanent ones. As we shall see, this aspect becomes relevant for understanding the allocation effects of commodity price booms since temporary changes in prices lead to current account adjustments that have long-run effects on the economy.

In what follows, before presenting our results, we briefly describe our parametrization strategy and then discuss different simple cases.

3.1. Parameters

We study the properties of the model using numerical simulations. We solve the model using a standard shooting algorithm.[16,17] Our framework is too simple to lend itself to a careful calibration exercise, hence our strategy consists in choosing reasonable values for the parameters in order to illustrate the model's properties, while we leave the study of a more realistic framework for future research with richer models (Table 1).

A period in the model corresponds to one year. We follow Benigno and Fornaro (2014) for the parametrization of the growth process. We set the growth rate of the technological frontier to $g^* = 0.015$, to match the average annual growth rate of TFP in the United States between 1960 and 1995 as computed by Benhabib and Spiegel (2005). In the benchmark parametrization the world interest rate is assumed constant and equal to $R = 1.04$. The discount factor is set to $\beta = 0.976$, so that in steady state consumption of tradable goods grows at the same rate of the world technological frontier. This essentially means that the economy shares the same discount factor as the rest of the world. The endowment of labor is normalized to $L = 1$. We assume that the economy starts with a net foreign asset position such that $\frac{B}{GDP} = 0$ or $\frac{B}{GDP} = -50\%$ depending on the exercise that we run, where *GDP* stands for gross domestic product and is measured in units of traded goods.

The initial values for the stock of knowledge of the home country and of the world technological leader are chosen with values

16 More precisely, we make a guess for the path of consumption of the traded good. Using the guess we solve the model and check whether the intertemporal resource constraint of the economy is satisfied. If this is not the case, we update the guess for the consumption of the traded good.

17 A solution satisfies the dynamic equilibrium conditions and the transversality condition $\frac{\beta^t B_t}{C_t} \to 0$. For any given C_0, we can solve contemporaneous variables and simulate a sequence of C^t so that the equation systems are satisfied by construction. It remains to find the initial consumption $C_0 = C_0^*$ such that the transversality condition is satisfied. This can be done by a bi-section algorithm. If $C_0 > C_0^*$, $\frac{\beta^t B_t}{C_t} \to -\infty$. As a result, if $\frac{\beta^t B_t}{C_t} \to -\infty$ in a simulation, we find the upperbound of $C_0^u > C_0^*$. If $C_0 < C_0^*$, $\frac{\beta^t B_t}{C_t} \to \infty$. As a result, if $\frac{\beta^t B_t}{C_t} \to \infty$ in a simulation, we find the lowerbound of $C_0^l < C_0^*$. As long as we have the initial two bounds we can simulate from $C_0 = \frac{C_0^u + C_0^l}{2}$ and update the upperbound or lowerbound according to the transversality condition. The gap between upperbound and lowerbound closes by one half in each iteration. The iteration stops either until the gap of the bounds is small enough or until $\frac{\beta^t B_t}{C_t}$ is close enough to 0 for large periods of simulation. When a balance growth path (BGP) exists, another terminal condition can be $\frac{B_{t+1}}{B_t} \to \beta R_t$. It is a sufficient condition for the transversality condition to satisfy. This is because, noting the Euler equation $C_{t+1} = \beta R_t C_t$, so $\frac{B_t}{C_t} \to$ constant and $\frac{\beta^t B_t}{C_t} \to 0$. It turns out the terminal condition $\frac{B_{t+1}}{B_t} \to \beta R_t$ leads to more precise solution of C_0^* for a finite T period simulation. This is because, the finite period approximation of $\frac{\beta^t B_t}{C_t} \to 0$ is equivalent to $B_T = 0$, while $B_T > 0$ is indeed the case. This advantage even carries to the scenario when BGP fails to exist.

Table 1
Baseline calibration.

Parameter	Symbol	Value
Growth rate of the technological frontier	g^*	0.015
World interest rate	R	1.04
Endowment of labor	L	1
Initial TFP of the technological leader	A_0^*	7
Initial TFP in traded sector	A_0^T	3
Initial TFP in the commodity sector	A_0^O	2
Initial TFP in the non-tradable sector	A_0^N	1
Share of tradable goods in consumption	ω	0.414
Elasticity of substitution	κ	0.75
Labor share in the tradable sector	α^T	1
Labor share in the non-tradable sector	α^N	1
Labor share in the oil sector	α^O	2/3
Intertemporal elasticity of substitution	ρ	1
Discount factor	β	$\frac{(1+g^*)^\rho}{R}$
Parameter for the elastic interest rate	ψ	0

consistent with the TFP estimates reported by Benhabib and Spiegel (2005). In particular, we set the initial stock of knowledge of the technological leader to $A_0^* = 7$.[18] The initial stock of knowledge for our small open economy is set to $A_0 = 3$. This calibration implies an initial proximity to the frontier equal to $a_0 = 0.42$. Moreover we set in the technology parameter for the commodity sector to $A_0^O = 2$ but we study the adjustment of the economy under different scenarios for higher TFP in the commodity sector ($A_0^O = 2.5$).

In our baseline case, we allow for dynamic productivity gains to be concentrated only in the traded sectors and we do not allow for any spillover effects. At this stage, we set the other parameters following Benigno and Fornaro (2014) as a way to illustrate the properties of the model. In particular we set $c^{TT} = 0.167$, the share of tradable goods in consumption is chosen equal to $\omega = 0.414$ so that after 26 years the ratio $P_t^N Y_t^N / Y_t^T$ is compatible with the ratio of non-tradable-to-tradable GDP provided by Hamann et al. (2015) for the Colombian economy.[19] We set the elasticity of intertemporal substitution $\rho = 1$, and the elasticity of intratemporal substitution between traded and non-traded goods to 0.75 a value that is consistent with the international business cycle literature. In terms of the production function, we let $\alpha^T = 1$, $\alpha^N = 1$ and $\alpha^O = 0.66$: in doing so, we allow for decreasing returns to scale in the commodity sector while we eliminate the effects of commodity goods on marginal costs in the other sector. In the robustness section we will allow for different labor shares in the traded and non-traded sectors to capture the fact that labor share is higher in the traded sector. We then set the risk premium elasticity to $\psi = 0.01$ for the debt-elastic case higher than the 0.005 estimated by Bergholt and Larsen (2016) for the Norwegian economy.

3.2. Analysis

We now analyze the properties of our economy. We are going to focus on two aspects of our model. The first is related to the patterns of specialization (i.e. the allocation of resources among the three sectors within our small open economy). The second aspect is related to how unexpected shocks affect the long-run pattern of specialization within our economy. We will then examine different special cases. In the first two cases our aim is to understand how the financial channel operates and to do so we abstract from the endogenous growth component of our model and technology spillovers (we set $c^{ii} = 0, \forall i = T, N, O$) by studying the impact of a commodity price booms under financial account autarky and openness. Then we examine the case of endogenous growth along with financial account openness to understand the interaction between growth and financial account.

Our first result, though, is independent on the structure of financial markets and the existence of the endogenous growth component and is related to the pattern of specialization determined by changes in the exogenous terms of trade between commodity and traded goods (i.e. P^O). The following proposition states that following commodity price changes it is possible for our economy to specialize completely in the production of commodity good.

The following proposition holds:

Proposition 1. *Under a constant return to scale production functions and perfect competition in the traded sector and commodity sector, then for sufficiently high value of P^O, the economy does not produce traded goods.*

Proof. From Eq. (11), we obtain an expression for the determination of the real wage in terms of traded goods price as

$$W_t = \frac{\left(A_t^T\right)^{\frac{1}{\alpha^T}} \left(\alpha^T\right)\left(1-\alpha^T\right)^{\frac{1-\alpha^T}{\alpha^T}}}{\left(P_t^O\right)^{\frac{1-\alpha^T}{\alpha^T}}},$$

so that the real wage is going to depend on productivity in the traded sector and the relative price of the commodity good. From Eq. (17), (under constant return to scale, i.e. $\alpha^O = 1$), we have

$$W_t = A^O P_t^O.$$

We note that the wage in both equations is a function of exogenous factors (the price of the commodity good, the productivity levels in the two sectors). When

$$A^O P_t^O > \frac{\left(A_t^T\right)^{\frac{1}{\alpha^T}} \left(\alpha^T\right)\left(1-\alpha^T\right)^{\frac{1-\alpha^T}{\alpha^T}}}{\left(P_t^O\right)^{\frac{1-\alpha^T}{\alpha^T}}}$$

is no longer profitable to produce traded goods and the economy produces only commodity and non-traded goods. This happens for a sufficiently high value of P^O:

$$P_t^O > \frac{\left(A_t^T\right)\left(\alpha^T\right)^{\alpha^T}\left(1-\alpha^T\right)^{1-\alpha^T}}{\left(A^O\right)^{\frac{1}{\alpha^T}}}.$$

■

Our result about the pattern of specialization is related to the Ricardian theory of comparative advantage. When the relative price of the commodity goods exceeds its relative costs, then resources tend to move towards the commodity sector. In the absence of non-traded goods, all labor will shift towards the commodity sector and the economy will specialize in the production of the commodity good. In the presence of non-traded goods, part of the labor supply is allocated to the production of non-traded goods that are consumed within the domestic economy, while the rest will be absorbed by the commodity sector. Conversely, if the price of the commodity goods drops beyond a critical level our economy will import the commodity goods for production purposes and will specialize in the production of traded goods.

We note here that our result on the pattern of specialization depends on the assumption of constant return to scale technology in the traded good sector only. More generally, we do not need constant return to scale in the commodity sector. Moreover, if we would assume decreasing return to scale in the traded sector, we would

[18] The value of TFP in the US in 1995 was around 6.4.

[19] Their value is equal to 1.76.

get an interior solution and the economy will always produce both traded and commodity goods.

As we noted above our proposition is independent of the financial market structure: it holds under financial autarky and financial openness. It is also independent on the presence of the endogenous growth component. Similar to the Ricardian economy, supply side factors matter for determining the pattern of specialization. The demand side here will determine the variable labor supply available to the commodity and traded sectors: indeed, changes in the commodity price will affect the demand of non-traded consumption that will determine the amount of labor allocated to the non-traded good sector and as such the residual amount that will be available to the other two sectors.[20]

The second aspect of the analysis that we want to highlight is specific to the structure of financial markets. Under financial openness, in our one bond small open economy any (temporary) shock generates a wealth effect that has permanent consequences on consumption, the allocation of labor among sector and relative prices. The existence of a wealth effect is a well-known property of a one-bond small open economy. Here we want to emphasize how this channel has implication for the allocation of resources among sectors following one particular type of shock (the commodity shock). The wealth effect could also lead to a permanent de-industrialization of the economy.[21]

3.2.1. The effects of a commodity price boom: the no growth case

We now study the response of our economy when there is no endogenous growth ($c^{TT}=0$). We focus on two cases: first we study the response of our economy under financial autarky and then under open financial account.

[20] The allocation of resources towards the non-traded goods is determined by Eq. (23) along with Eq. (15) and the current account Eq. (20). When the commodity sector has constant return to scale (as in the proposition) there is no feedback from this set of equations for determining the path of resources between traded and commodity sectors.

[21] We are thankful to Martin Uribe for emphasizing this aspect in his discussion. To illustrate this case, we simplify our economy by further considering the case in which $\alpha^N=\alpha^T=\alpha^O=1$, so that the only variable input is labor, with $\beta R=1$ and $\rho=\kappa=1$. Under the knife-edge case in which $P_t^O=\frac{A_t^T}{A_t^O}$ all goods could be produced (we could have an interior solution). When $P_t^O\neq\frac{A_t^T}{A_t^O}$ then either only traded goods are produced $\left(P_t^O<\frac{A_t^T}{A_t^O}\right)$ or only commodity goods are produced $\left(P_t^O>\frac{A_t^T}{A_t^O}\right)$ and the economy exports commodity goods to finance traded good consumption. Moreover, we have that

$$P_t^N=\frac{A_t^T}{A_t^N},$$

and (by assuming $\omega=0.5$) from Eqs. (23) and (20) we obtain (in steady state):

$$P^N=\frac{C^T}{C^N}=\frac{A^T(1-L^N-L^O)+\left(\frac{R-1}{R}\right)B+P^OL^O}{A^NL^N}.$$

We can combine the two expressions that determine the relative price of non-traded goods as in (in steady state):

$$\frac{A^T}{A^N}=\frac{A^T(1-L^N-L^O)+\left(\frac{R-1}{R}\right)B+\frac{A^T}{A^O}L^O}{A^NL^N}.$$

This expression shows that as the asset position rises there is an increase in the quantity of labor allocated to the non-traded sector. For a sufficiently high level of the asset position

$$B>\frac{R}{R-1}\left[A^TL^N-\frac{A^T}{A^O}(1-L^N)\right]$$

we have that the traded sector disappears and the economy experiences full de-industrialization in the long-run.

Fig. 3 summarizes the adjustment of the economy following an increase in commodity prices for 10 periods under financial autarky and financial openness (bond economy). In the figure we also plot the "benchmark" case in which the economy is not subject to any shock.

We first discuss the autarky case. As in Corden and Neary (1982), there are two effects, the resource allocation effect and the spending effect. The boom in the commodity sector raises its marginal product of labor, drawing resources out of the other sectors. The spending effect arises from the increase in real income following the commodity price boom and leads to a higher consumption of traded and non-traded goods.

In our economy and under our parametrization, the resource movement effect leads to an increase in the labor share employed in the commodity sector and a full de-industrialization as labor share in the traded sector drops to zero. Because of the spending effect, households consume more of both traded and non-traded goods. Higher non-traded good consumption is accommodated by a shift of resources towards the non-traded sector while the increase in traded consumption is obtained by importing traded goods from abroad and financing them by commodity exports. Once the commodity boom ends the economy goes back to its initial state. An interesting aspect of the adjustment mechanism is that when the economy experiences a period of complete de-industrialization[22] (the traded labor share goes to zero), then the real exchange rate initially appreciates and then goes back to its initial value once the boom ends. Indeed, when there is de-industrialization, the determination of the relative price is no longer given by the supply side (since traded goods are no longer produced) but is obtained from the demand side.[23]

When financial account is open, there are few differences relative to the autarky case. When a country borrows and lends from abroad, accumulation or decumulation of net foreign assets (as long as the world interest rate is positive) gives rise to a wealth effect. This is a general property of a one bond small open economy.[24] As discussed earlier, this wealth effect plays a key role in determining the pattern of production and the resource allocation among the three sectors of our economy.[25] Earlier we have shown that even under a temporary commodity price boom there could be a permanent shift of resources out of the traded good sector. When the economy is richer (due to temporary higher commodity prices) it runs a current account surplus and smooth traded consumption. The increase in tradeable consumption leads to an increase in non-traded consumption and a shift of resources towards the commodity and non-traded good sectors. When the commodity boom ends, the only way for the economy to sustain higher non-traded consumption is by shifting resources towards the non-traded good sector out of the traded sector. The wealth effects generated from the financial channel have permanent consequences in terms of resource allocation.

Moreover, similar to the case of financial autarky, and depending on the size of the commodity boom, the economy could experience a period of complete de-industrialization that generates fluctuations in non-traded consumption and the real exchange rate despite the possibility of smoothing consumption and even when all technologies are constant return to scale (as in the figure).

3.2.2. The effects of a commodity price boom: growth case

We now study the response of our economy when the traded sector experiences dynamic productivity gains and the economy

[22] The possibility of full de-industrialization is ruled out in Corden and Neary (1982) and Van der Ploeg and Venables (2013).

[23] We note here that when the commodity price returns to its initial value, there is a one-period adjustment in the real interest rate. Indeed, under financial autarky the real interest rate is endogenously determined.

[24] See also Van der Ploeg and Venables (2013) on this.

[25] This wealth effect is not present in Corden and Neary (1982) as they focus on permanent shocks or financial autarky case.

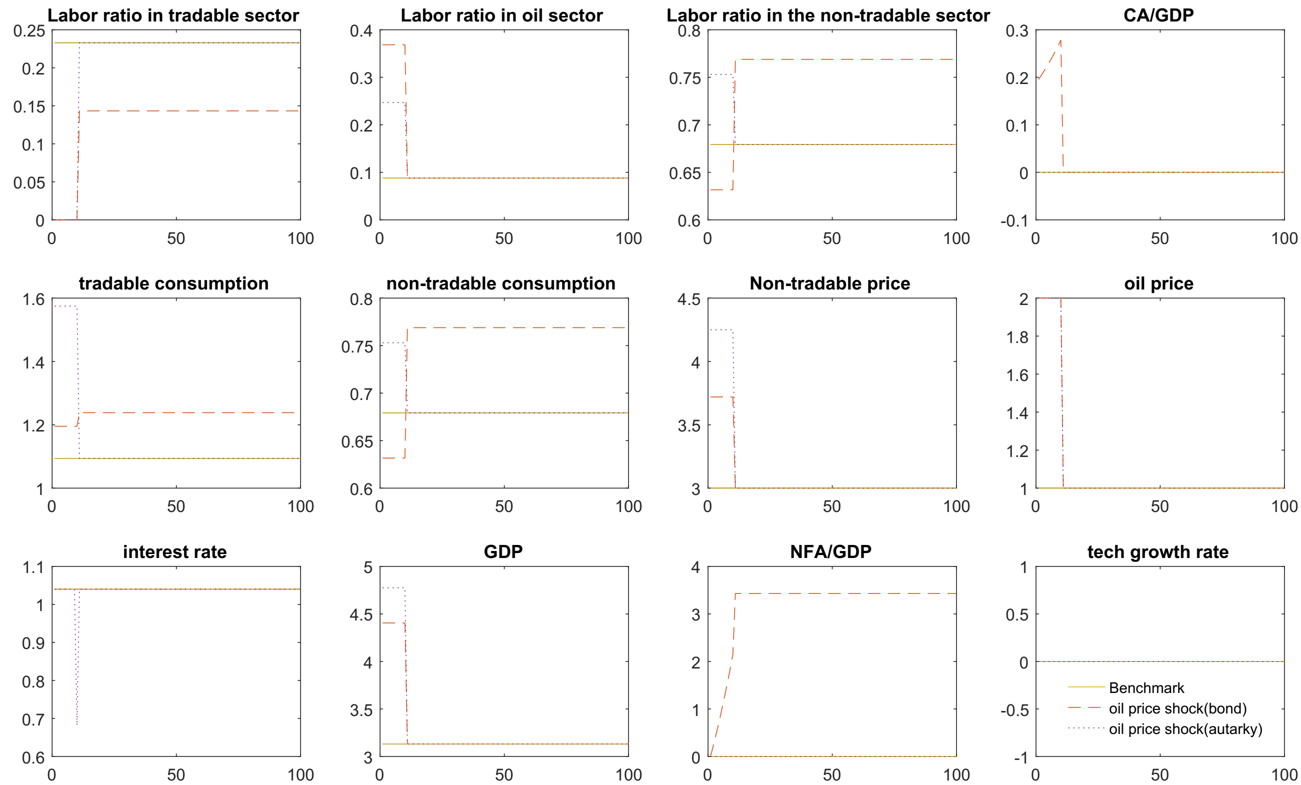

Fig. 3. Commodity boom with no growth.

converges eventually to the world technology frontier. As before we distinguish between financial autarky and financial openness.

In general, the presence of dynamic productivity gains, and in particular the anticipation of these gains, induces agents to borrow as the economy is expected to converge towards the balanced growth path as long as the economy starts below its steady state proximity to the foreign technological frontier. This effect results into a current account deficit that counterbalances the effect of a temporary commodity price boom (which tends to generate a current account surplus).

In Fig. 4, we represent the adjustment of the economy following a temporary commodity price boom (dashed line) under financial autarky. The solid line shows the transitional dynamic of the economy without commodity price boom. In the latter case, the stock of knowledge grows faster than the growth rate of the world technological frontier. Indeed, initially, annual productivity growth is above 2%, higher than in the steady state (1.5%). As the economy approaches the steady state, we observe an increase in the share of labor allocated to the traded sector and a declining share to the commodity and non-traded sectors. Note here that in both scenarios (with and without the commodity price boom), the economy converges towards the same equilibrium path.

When there is a commodity price boom, the transition towards the steady state is delayed and in the extreme case of complete de-industrialization, there is no productivity growth as long as the economy experiences the boom since labor is reallocated towards the commodity and non-traded sectors.

Finally, in Fig. 5, we show the response of the economy under financial openness.

We note that a commodity boom leads to an improvement in the current account compared to the benchmark economy (solid line) that worsen once the boom ends. Again, during the boom, the economy stops producing traded goods but then, after the boom ends, it starts allocating resources towards the traded sector and eventually the economy converges (slowly) towards the world technology frontier. The key difference with respect to the case of financial autarky is that the temporary boom has permanent effect on the allocation of resources among the different sectors. The size of the commodity price boom determines the patterns of the resource allocation. In our example there is a significant increase in commodity prices and a shift of resources out of traded and non-traded sectors towards the commodity sector. Under financial openness, the economy initially runs a current account surplus and, once the boom ends, it borrows as long as the economy converges towards the world technology frontier. The commodity boom delays the catching up process and once the boom ends the economy shifts resources back towards the traded good sector and finances the consumption boom by borrowing more heavily from abroad. Lower net foreign asset position eventually results in lower consumption of both traded and non-traded goods as the economy is relatively poorer (compared to the benchmark case of no commodity shock) due to the delayed convergence towards the technology frontier.

Interestingly, there is now the possibility that the economy ends up in a growth trap. In Fig. 6, we allow for a relatively more productive commodity sector at the beginning of the economy (from $A_0^O = 2$ to $A_0^O = 2.5$). As before, the commodity boom triggers complete de-industrialization. When the boom ends, labor shifts back to the traded sector but the rate of growth of the traded sector is not high enough compared to wage growth and eventually producing traded goods becomes non-profitable. There are few aspects of this result that we want to emphasize: under our parametrization, if there was no commodity shock, the economy will converge towards the balanced growth path so the commodity boom is the causal factor in determining the outcome. Alternatively, the possibility of a growth trap depends crucially on the initial conditions of the technology in the traded sector versus the commodity sector. In our example, the commodity price boom makes the traded sector non-profitable but it might well happen that, for higher TFP in the commodity sector, the economy converges towards a growth trap even in the absence of an external shock. Moreover, under financial openness there are permanent implications on resource allocation caused by wealth effects as the economy runs a surplus in the current account. Indeed, when the commodity boom ends and the economy has accumulated net foreign assets, resources shift towards non-traded sector and the economy can consume higher non-traded goods compared to the boom phase.

4. Extensions and robustness analysis

In this section we extend our model and we conduct some robustness analysis along some potentially critical assumptions and parametrization that we have chosen.

4.1. Debt-elastic interest rate

One aspect of interest in understanding the financial channel associated with the commodity curse is given by the observation that during the commodity boom, spreads on sovereign bonds of exporting countries are lower (see IMF (2015)). In order to capture changes in borrowing conditions from a country's point of view, we allow for the possibility that the interest rate on foreign debt is debt-elastic:

$$R_t = R^* + \psi\left(e^{\frac{-B_t}{A_t^* P_t^T}}\right) \text{ for } B_t < 0 \tag{24}$$

$$R_t = R^* \text{ otherwise}$$

so that when a country borrows from the rest of the world, it pays a premium that is a function of the current net debt position. In principle, a commodity boom, should lead to an improvement in the external debt position and as such a reduction of the interest rate at which the country borrows. We label this effect "interest rate channel" that would stimulate expenditure when the interest rate at which the country borrows declines.

We now examine numerically the situation in which the economy starts with an external debt position.

We assume that initial debt position is 50% of gross domestic product and examine the impact of commodity price boom under this scenario where the interest rate, at which the country borrows, depends on the amount of external debt as in Eq. (24). This exercise is meant to capture another financial channel through which commodity boom might affect the commodity-exporting economy. In Fig. 7, we compare the adjustment of the economy following a commodity price boom, starting from the same debt/GDP ratio, under the scenario in which the interest rate is fixed and when the interest rate depends on the amount of external debt.

With debt-elastic interest rate, as long as the country holds a debt position, consumption is lower compared to the fixed interest rate case. This allows more resources to be shifted towards the commodity sector during its price boom, resulting in higher current account surpluses and faster reduction in the external debt position. Eventually the country accumulates higher net foreign assets and consumes more of both traded and non-traded goods. Once the commodity boom ends, the financial channel that works through a reduction of the foreign interest rate has also permanent effects in terms of resource allocation: indeed, similarly to what we have described before, higher consumption requires further shift of resources out of the traded good sector towards the non-traded sector. We note here though, that under our parametrization, the effects of this channel on the resource allocation among sectors are quite small.

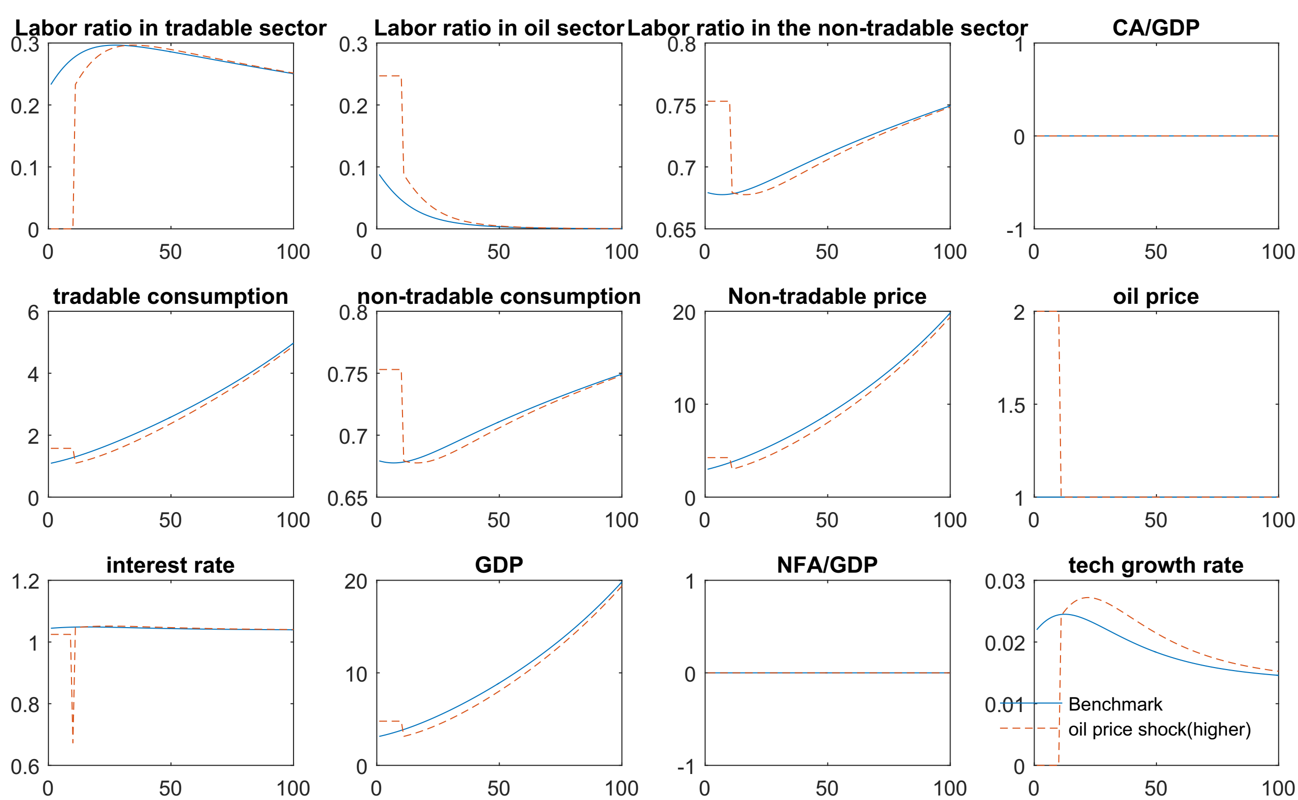

Fig. 4. Commodity boom under financial autarky with learning by doing and growth.

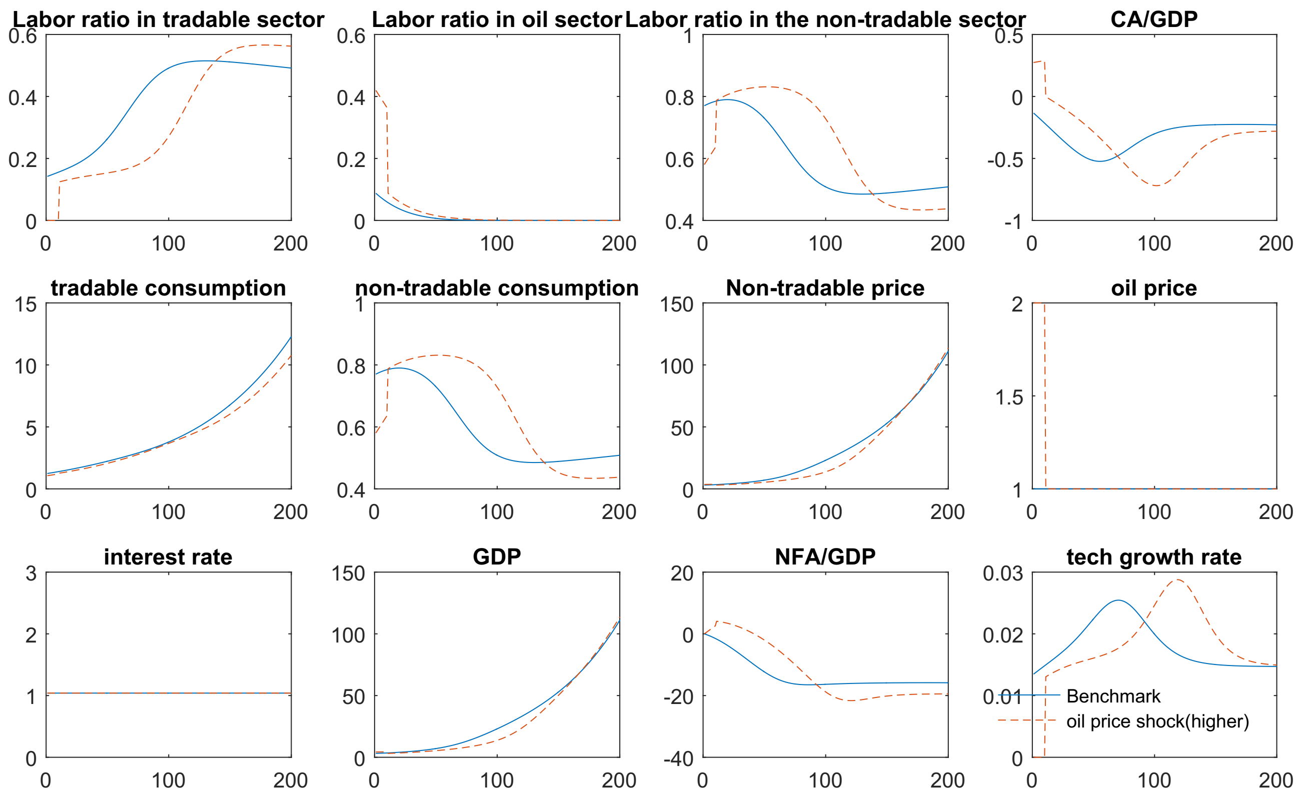

Fig. 5. Commodity boom under financial openness with learning by doing and growth.

4.2. *Dynamic productivity gains and technological spillovers*

In our analysis we have focused on the case in which dynamic productivity gains are concentrated only in the traded sectors. We have shown that there is a possibility of a growth trap following a commodity price boom that depends on the relative productivity of the oil price sector at the start of the boom cycle. One might argue that the assumption that the trade sector is the sole contributor to dynamic productivity gains is restrictive and might not be a realistic approximation for some countries. For example, in the case of Norway, Bjørnland and Thorsrud, 2016 show, empirically, that a booming energy sector has spillover effects on the non-oil sector, while Torvik (2001) discusses the theoretical implications of a more general setting similar to the one that we propose.

We now allow for a more general case in which technology evolution is then represented by the following set of equations:

$$A_{t+1}^{T} = A_t^{T}\left(1 + c^{TT}L_t^{T}\left(1-\frac{A_t^{T}}{A_t^{*}}\right) + c^{TN}L_t^{N}\left(1-\frac{A_t^{N}}{A_t^{*}}\right) + c^{TO}L_t^{O}\left(1-\frac{A_t^{O}}{A_t^{*}}\right)\right). \tag{25}$$

$$A_{t+1}^{N} = A_t^{N}\left(1 + c^{NT}L_t^{T}\left(1-\frac{A_t^{T}}{A_t^{*}}\right) + c^{NN}L_t^{N}\left(1-\frac{A_t^{N}}{A_t^{*}}\right) + c^{NO}L_t^{O}\left(1-\frac{A_t^{O}}{A_t^{*}}\right)\right). \tag{26}$$

$$A_{t+1}^{O} = A_t^{O}\left(1 + c^{OT}L_t^{T}\left(1-\frac{A_t^{T}}{A_t^{*}}\right) + c^{ON}L_t^{N}\left(1-\frac{A_t^{N}}{A_t^{*}}\right) + c^{OO}L_t^{O}\left(1-\frac{A_t^{O}}{A_t^{*}}\right)\right). \tag{27}$$

where $c^{ii} > 0$, with $i = T, N, O$ is a parameter determining the impact of the sectoral labor allocation on productivity growth, and A_t^*, as before, denotes the stock of knowledge of the world technological leader, which grows at the constant rate g^*. Our assumptions about technology evolution imply that the stock of knowledge in a generic period t for sector $i = T, N, O$ depends not only on the past sector specific knowledge, but also on the amount of labor employed in each sector. Moreover,there is a possibility that there are positive spillovers from other sectors. We assume in general that the direct effect is bigger compared to the spillover effect so that $c^{TT} > c^{TN}, c^{TO}$, $c^{NN} > c^{NT}, c^{NO}$ and $c^{OO} > c^{ON}, c^{OT}$.

Once we allow for dynamic productivity gains as in Eqs. (26), (27) and (25), it will always be the case that the commodity sector and the non-traded sector will eventually grow at the same rate as the technological frontier. Indeed, commodity will always be produced under decreasing return to scale while non-traded goods will be always produced as long as household preferences are well-behaved. As in the previous situation, a growth trap could arise if the traded sector disappears and all resources are allocated in the other two sectors.

Resource allocation in the traded sector is now influenced by two different channels. Higher spillover effect into the traded sector (c^{TN} and c^{TO} relatively higher) tends to limit the occurrence of a growth trap as resource will shift in to the traded sector, while stronger dynamic productivity gains in the commodity and non-traded sectors (c^{NN} and c^{OO} relatively higher) and spillovers into those sectors (c^{NT}, c^{NO} and c^{OT}, c^{ON} relatively higher) generate a crowding out effect resulting in a shift of resources out of the traded sector, increasing the likelihood of a growth trap.

In Fig. 8, we construct an example in which, the presence of spillovers eliminates the possibility of a growth trap under financial

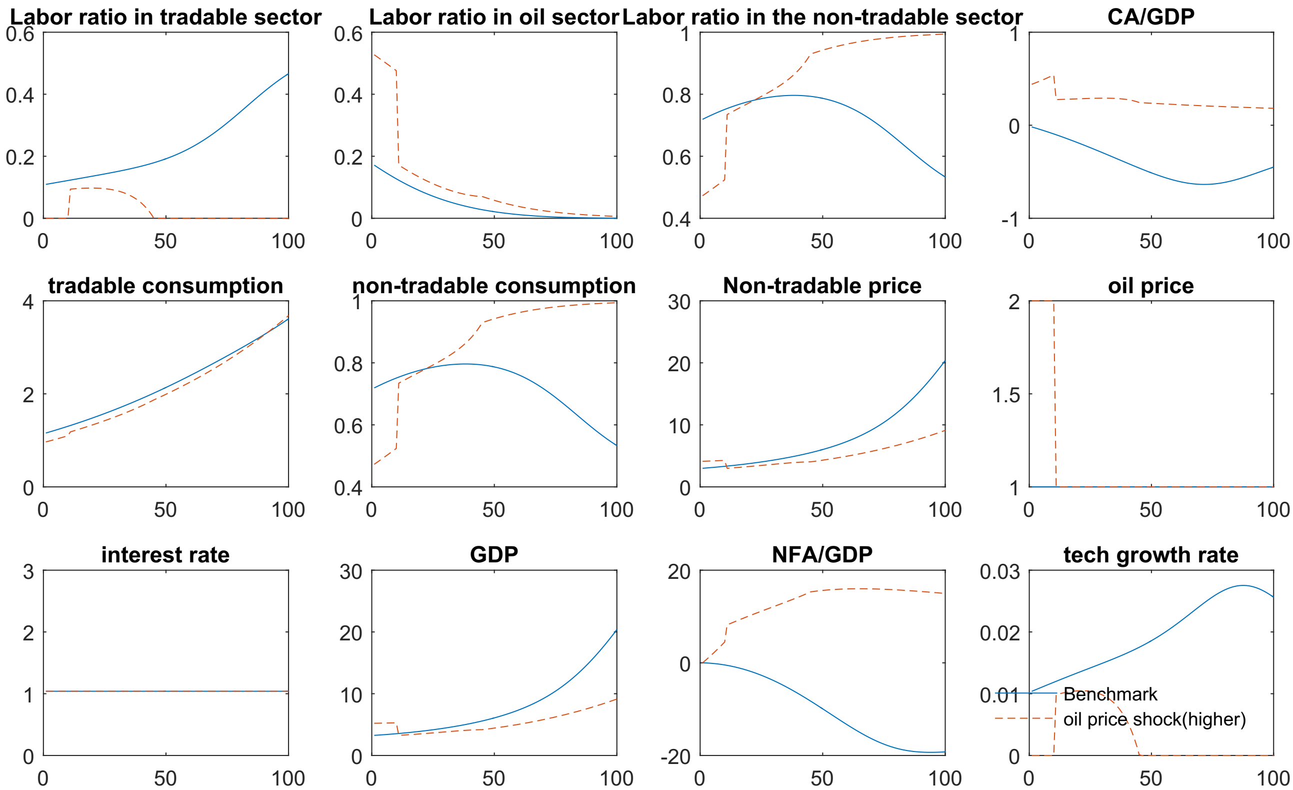

Fig. 6. Commodity boom under financial openness, growth trap.

openness. We set $A_0^O = 2$ and $c^{TT} = 0.167$ as in the case of the growth trap under financial openness, and then $c^{TN} = c^{TO} = 0.03$ and $c^{NN} = c^{OO} = 0.05$. As before, during the commodity boom, there is complete de-industrialization. In this case, as the benefit of a growing commodity and non-traded sectors spreads over productivity in the traded sector, once the boom ends, resources shiftback to the traded sector that eventually converges at the speed of the world technology frontier. Again, the presence of a wealth effect, generates permanent shift of resources out of the traded sector towards the non-traded sector to sustain higher consumption in the long-run.

5. Welfare

We conduct our welfare analysis along two dimensions. We first characterize the social planner problem and then we compare the welfare gains/losses from opening up financial markets for our small open economy. The social planner maximizes households' utility Eq. (1) by choosing $\left\{C_t^T, C_t^N, B_{t+1}, L_t^T, L_t^N, L_t^O, M_t^{O,T}, M_t^{O,N} A_{t+1}\right\}$ subject to the economy-wide resource constraints (19), (20), and (21) and the technology constraints (8), (12), (16) and (18).

The social planner takes into account the effect that labor allocation has on the accumulation of knowledge in the traded sector. If we denote with $\lambda_1, \lambda_2, \lambda_3$, the multiplier associated with Eqs. (19), (20), and (21) respectively, where we have substitute out Eqs. (8), (12), and (16), and with μ the multiplier associated with the knowledge accumulation, we obtain the following first order conditions:

$$C^N : (C_t)^{-\rho}\left(\frac{C_t^N}{C_t}\right)^{-\frac{1}{\kappa}}(1-\omega)^{\frac{1}{\kappa}} = \lambda_{1,t}$$

$$C^T : (C_t)^{-\rho}\left(\frac{C_t^T}{C_t}\right)^{-\frac{1}{\kappa}}(\omega)^{\frac{1}{\kappa}} = \lambda_{2,t}$$

$$B_{t+1} : \lambda_{2,t} = \beta R_t \lambda_{2,t+1}$$

$$L^T : \lambda_{2,t}\alpha^T \frac{Y_t^T}{L_t^T} == \lambda_{3,t} - \mu_t c^{TT} A_t^T \left(1 - \frac{A_t^T}{A_t^*}\right)$$

$$L^N : \lambda_{1,t}\alpha^N \frac{Y_t^N}{L_t^N} == \lambda_{3,t}$$

$$L^O : \lambda_{2,t}\alpha^O \frac{Y_t^O}{L_t^O} == \lambda_{3,t}$$

$$M^{O,T} : \left(1-\alpha^T\right)\frac{Y_t^T}{M_t^{O,T}} == P_t^O$$

$$M^{O,N} : \lambda_{1,t}\left(1-\alpha^N\right)\frac{Y_t^N}{M_t^{O,N}} == \lambda_{t,2} P_t^O$$

$$A_{t+1} : \mu_t = \beta\mu_{t+1}\left(1 + c^{TT} L_{t+1}^T\left(1 - 2\frac{A_{t+1}^T}{A_{t+1}^*}\right)\right) + \beta\lambda_{2,t+1}\alpha^T \frac{Y_{t+1}^T}{A_{t+1}}. \tag{28}$$

Not surprisingly, once we compare the social planner allocation with the competitive equilibrium one, we find that the main difference relates to how the social planner allocates labor towards the traded sector compared to the competitive allocation. Once $P_t^N = \frac{\lambda_{1,t}}{\lambda_{2,t}}$, $W_t = \frac{\lambda_{3,t}}{\lambda_{2,t}}$, and $\nu_t = \frac{\mu_t}{\lambda_{2,t}}$, we can rewrite the first order condition for the social planner with respect to L_t^T as:

$$\alpha^T \frac{Y^T}{L^T} = W - \nu c^{TT} A^T \left(1 - \frac{A^T}{A^*}\right). \tag{29}$$

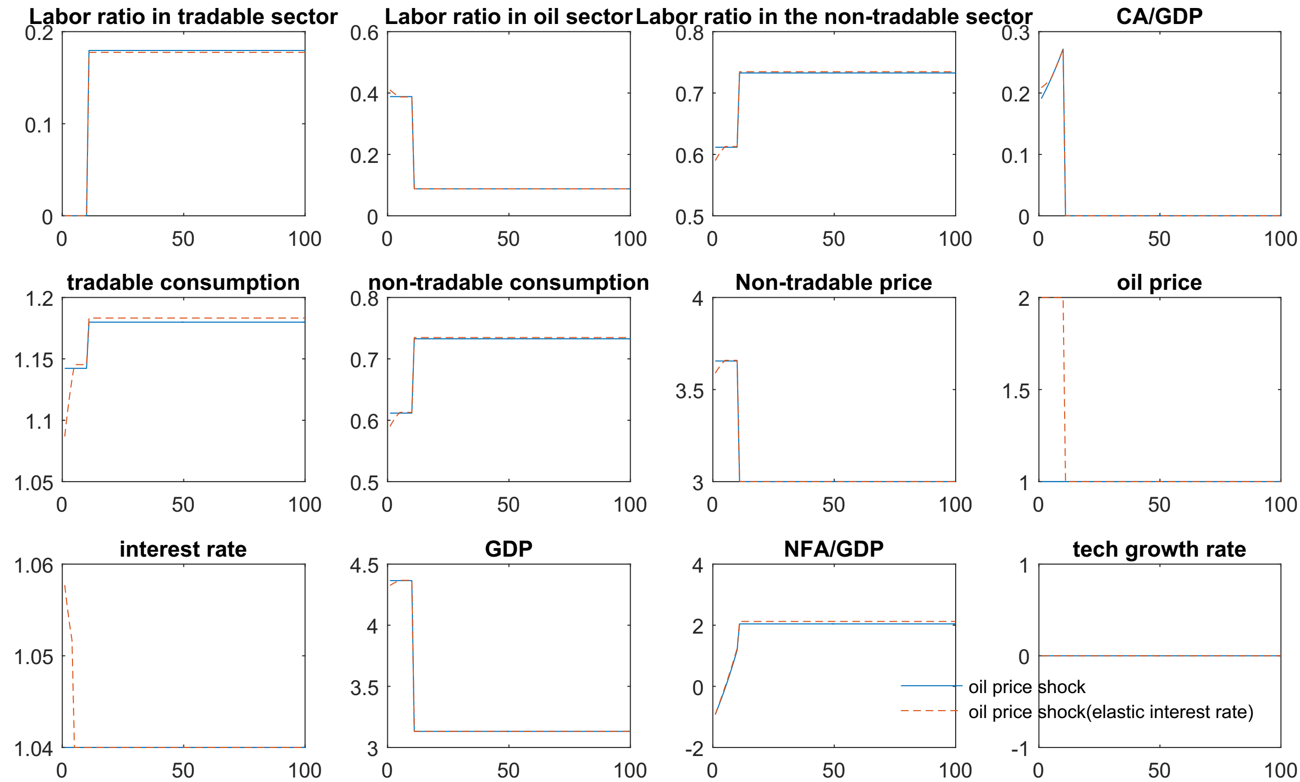

Fig. 7. Commodity boom under financial autarky, and elastic interest rate. No growth or learning by doing.

When the social planner values higher A^T_{t+1}, we have that $\nu_t > 0$.[26] As a result, the right-hand side of Eq. (29) is smaller. Due to decreasing returns to scale for L^T, we have $L^{T,soc} > L^{T,com}$. The social planner would like to allocate more labor to the tradable sector for given wage.

In what follows, we use the social planner allocation as our benchmark case in conducting our comparative welfare analysis that studies the implications of alternative financial market structures when the economy is subject to a boom in commodity prices.

We compute the impact on welfare of ten years of high commodity prices as the percentage increase in consumption that the representative household has to receive in any future date in order to be indifferent between staying in the benchmark economy or moving to the economy with relatively higher commodity prices. Formally, the certainty equivalents η from a consumption sequence $\{C^T_t, C^N_t\}^{\infty}_{t=0}$ against the benchmark $\left\{C^{T,B}_t, C^{N,B}_t\right\}^{\infty}_{t=0}$ are defined as

$$\sum_{t=0}^{\infty} \beta^t \log C_t = \sum_{t=0}^{\infty} \beta^t \log[(1+\eta)C_t],$$

where in our case the benchmark economy is the social planner allocation under the baseline calibration so that higher value of the certainty equivalent implies higher welfare compared to the benchmark case.

In our experiments we have focused on two scenarios. In the first scenario we have studied the allocation of resources when there are no dynamic productivity gains: we have shown that, under financial openness, a temporary commodity shock can have permanent effects on resource allocation. Moreover, during the temporary boom, the economy might de-industrialize and could stop producing traded goods. From the characterization of the social planner problem, it follows that these adjustments are always efficient and there is no scope to improve upon the competitive equilibrium allocation.

Under this scenario (see Fig. 9), financial openness is always welfare improving as the economy accumulates foreign assets and enjoys a permanent increase in consumption. Moreover, a commodity price boom has positive welfare effects on the economy.

The second scenario allows for dynamic productivity gains in the traded sector. We learnt that depending on initial conditions, the economy could end up in a growth trap. In Fig. 10, we plot the certainty equivalence consumption gains/losses as we vary the initial technological factor in the commodity sector.

Conditional on our parametrization, welfare gains and losses are nonlinear.

Let's consider the case of financial autarky first (represented by the red line when there is a commodity boom and a blue line when there is no commodity boom). As long as the technology in the commodity sector is relatively weaker than the traded sector one, we observe that a commodity boom reduces welfare as the technology in the commodity sector improves: this is so because the economy delays its convergence towards the world technological frontier. This effect dominates the benefits from the higher technology level in the commodity sector. Under our parametrization, once A^O_0 is bigger than 2.9, a commodity boom is always welfare improving. However, there is a region after which there is a significant increase in the welfare losses (for values of $2.8 < A^O_0 < 2.9$): the losses occur because the economy enters a growth trap in which the traded sector is not produced.

A similar pattern arises when we examine welfare gains and losses under financial openness (represented by the purple line when there is a commodity boom and a yellow line when there is no

[26] We have that:

$$A_{t+1} : R_t \nu_t = \nu_{t+1}\left(1 + c^{TT} L^T_{t+1}\left(1 - 2\frac{A^T_{t+1}}{A^*_{t+1}}\right)\right) + \alpha^T \frac{Y^T_{t+1}}{A_{t+1}}.$$

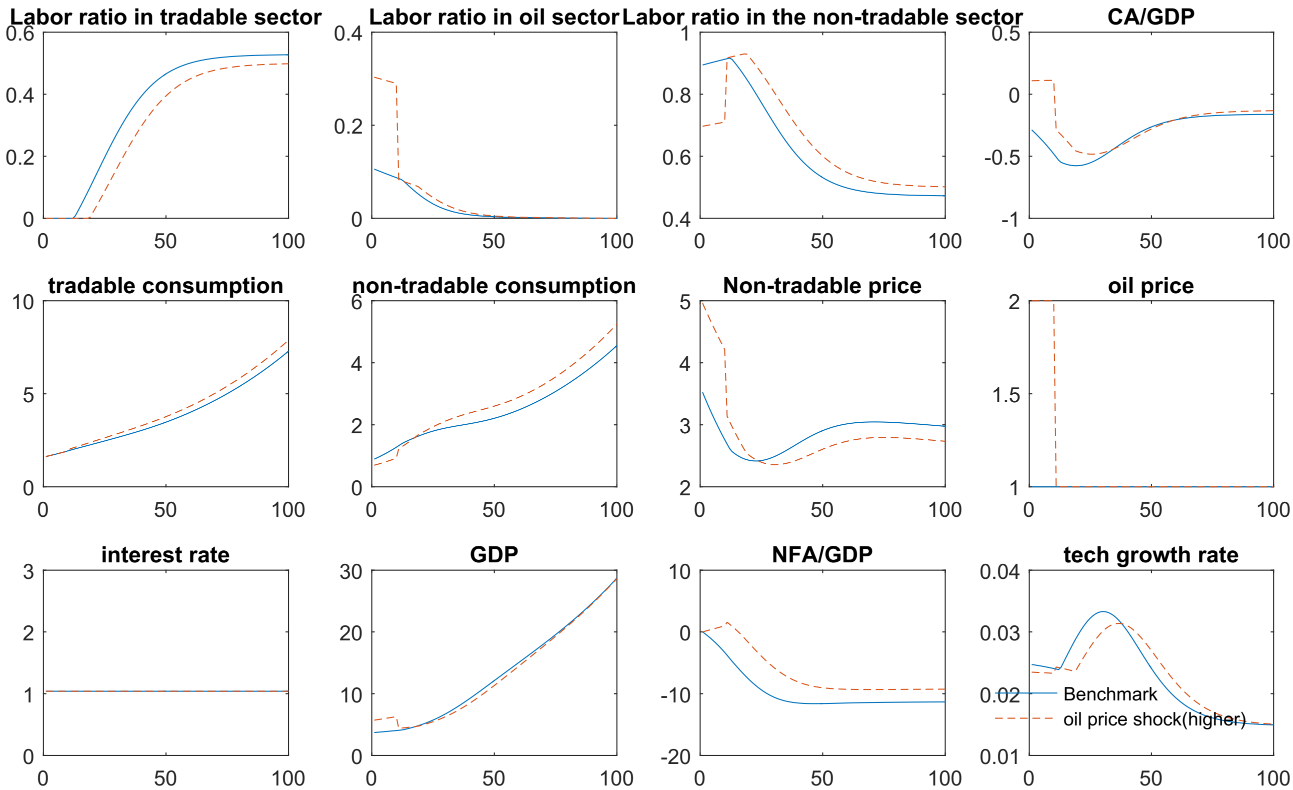

Fig. 8. Commodity boom under financial openness and spillover.

commodity boom). One aspect to emphasize here is that, depending on the initial value of A_0^O the economy could be worse off under financial openness relative to financial autarky. Under our parametrization, this occurs for values of A_0^O just below 2.3. The ability to borrow leads to an increase in consumption and in particular of non-traded consumption that shift labor out of the traded sector delaying the process of convergence. Eventually, for higher values of A_0^O, when there are no dynamic productivity gains and the economy

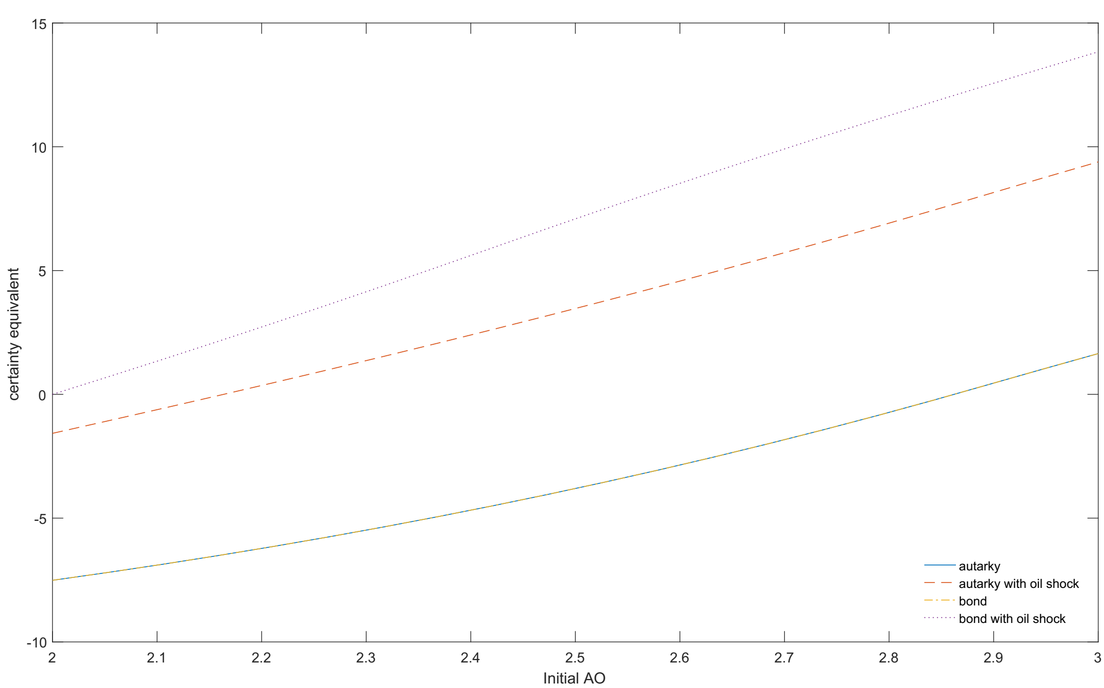

Fig. 9. Certainty equivalents when there are no growth and catch-up.

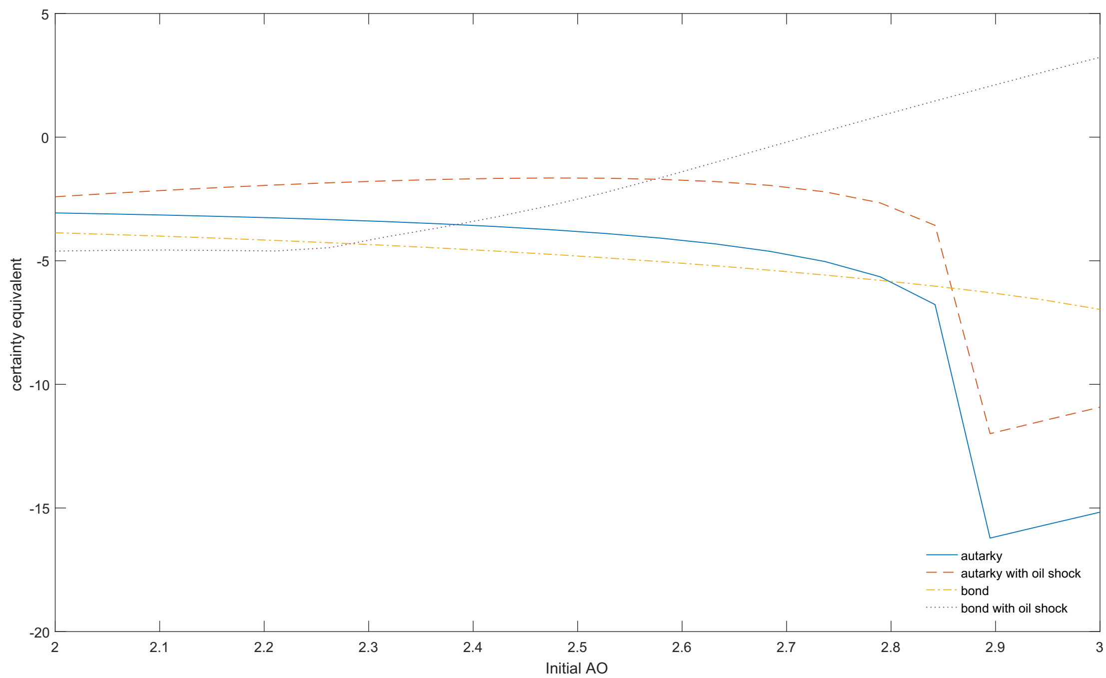

Fig. 10. Certainty equivalents when there are growth and catch-up.

is in a growth trap, opening up to international financial markets is beneficial for the standard consumption smoothing argument.[27]

Finally, we examine the extent to which commodity price booms are beneficial for our small open economy. As in the case of no commodity price boom, welfare gains and losses are U-shaped and for relatively low value of A_0^O, the autarky economy dominates in consumption equivalent terms, the economy under financial openness. For both financial autarky and financial openness, a temporary commodity price boom has a negative effect on welfare for relatively low value of A_0^O. Indeed, for higher commodity prices, there is a shift of labor out of the traded sector that delays the convergence process. For higher values of A_0^O, the economy does not produce traded goods (i.e. it enters a growth trap) and eventually benefits from higher commodity prices since they generate positive wealth effects for a commodity exporter economy.

6. Conclusion

In this paper we have studied the consequences of commodity price fluctuations for a small open economy that is open to international financial markets. We show that under financial account openness, a temporary commodity boom leads to an (initial) accumulation of net foreign assets that results in a permanent shift of resources out of the traded sector. This comes about through the standard wealth effect that arises in a bond small open economy. When we introduce dynamic productivity gains into the traded sector, a commodity boom crowds out the traded sector and delays convergence to the world technology frontier. Financial openness by stimulating current demand, amplifies this crowding out effect. Finally, in the presence of learning by doing externalities concentrated in the traded sector, commodity prices boom can lead to costly permanent de-industrialization ("growth trap"). From a normative point of view, policies of capital account management which would limit international borrowing and lending in the adjustment following a commodity shock could be welfare enhancing for our small commodity exporter economy. Similarly, fiscal instruments such as stabilization fund or a tax where commodity revenues could accrue and be redirected to traded good sector would also reduce the drive towards de-industrialization and improve welfare.

There are several ways in which it would be interesting to generalize further our analysis. On the production side it would be interesting to study the situation in which the supply chain is modeled in a richer and more realistic way as in Bergholt and Larsen (2015): in their case traded goods serve as an input in the production processes of non-traded and commodity goods enriching the analysis with a further demand effect. Another interesting extension would be to study the role of capital accumulation and its role in the adjustment process. It would be also of interest to study the case of a small open economy that specializes in the production of differentiated traded goods: in this case the economy would no longer stop in producing its own traded good and scope for policy intervention arises from the presence of terms of trade externality (see De Paoli (2009)). These insights could be complemented by the consideration of borrowing in international currency (i.e. there is liability dollarization) so that changes in the real exchange rate affect debt/credit position of an economy that could have long-lasting impact on the resource allocation. Finally, a full-fledged normative analysis of alternative fiscal instruments and the role of a stabilization fund would be also desirable (Figs. 11, 12, and 13).

Appendix A

A.1. Relative factor intensities

In our baseline calibration[28] we have focused on the case in which the only variable input in the traded and non-traded sectors is labor

[27] Eventually, as the technology in the commodity sector improves, there are welfare gains relative to the benchmark case. This is because once technology in the commodity sector becomes very productive shifting resource in that sector is not that costly. Also in the benchmark social planner case we keep the technology level in the commodity sector at the value of $A_t^O = 2$.

[28] We are assuming that $g = 0$ and $c = 0$ in what follows.

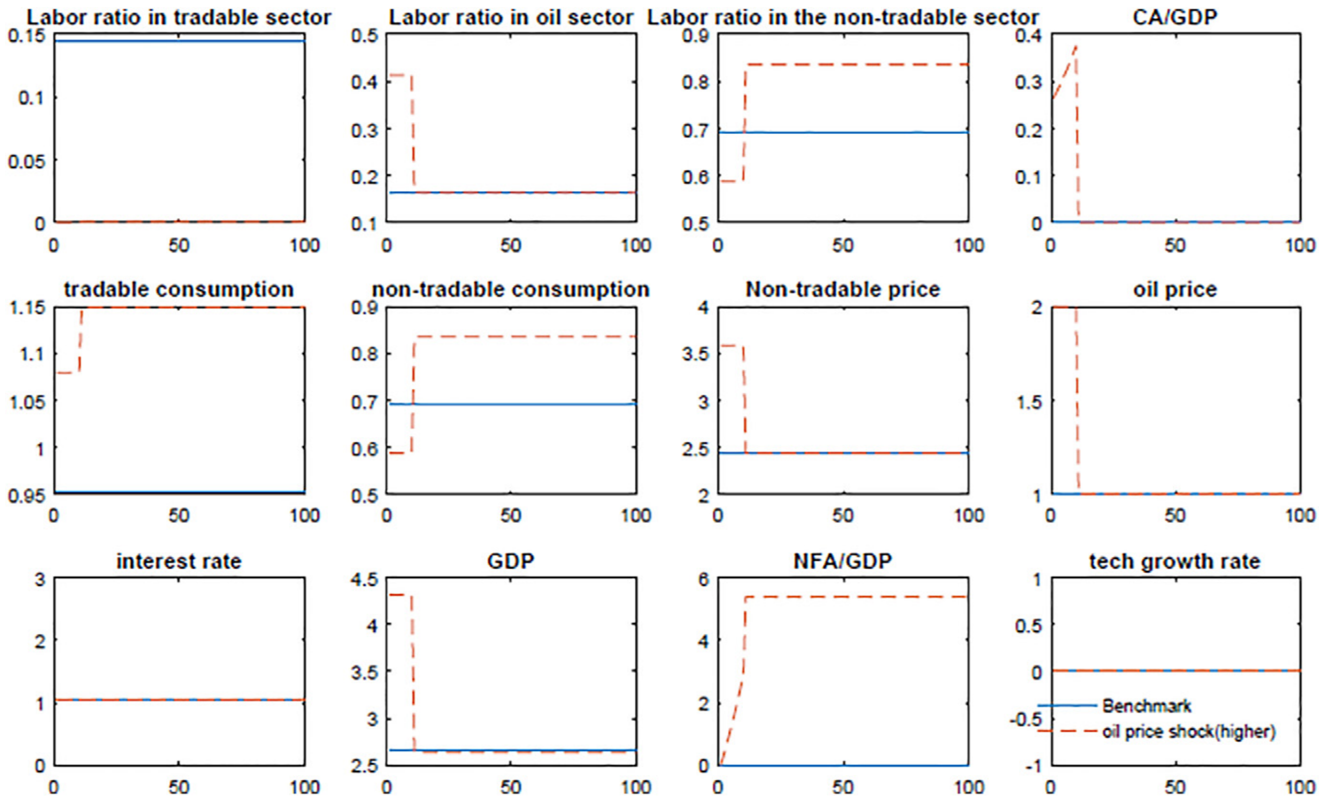

Fig. 11. Relative factor intensities. Case A, $\alpha^N > \alpha^T$.

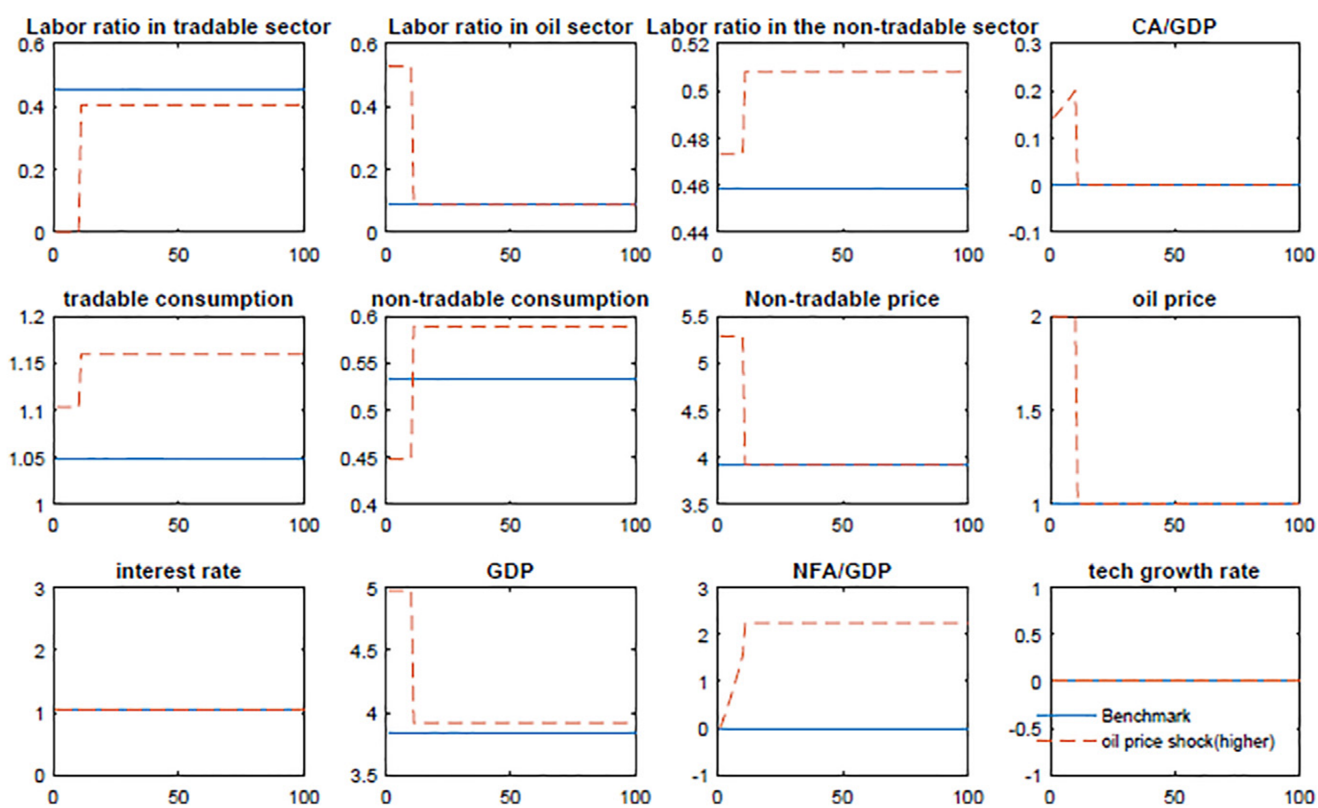

Fig. 12. Relative factor intensities. Case B, $\alpha^T > \alpha^N$.

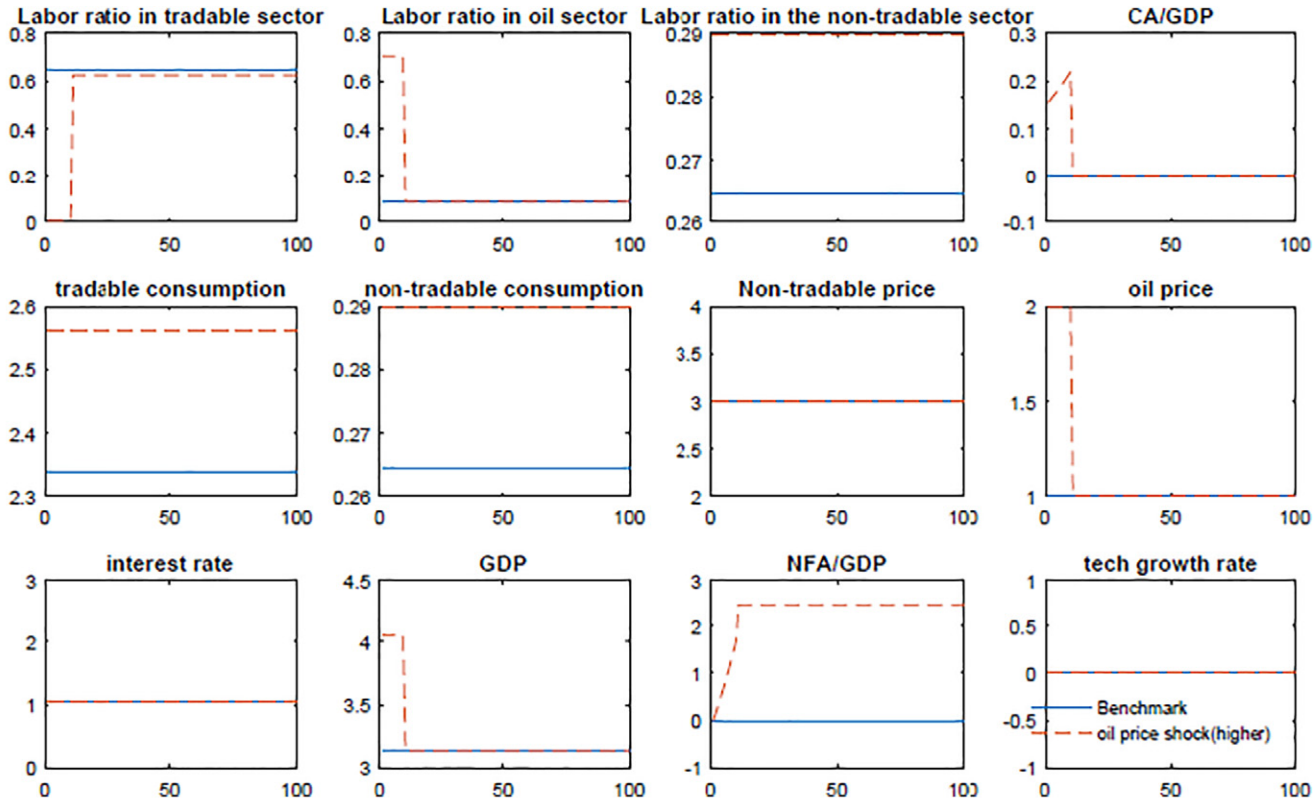

Fig. 13. Higher sustitutability between traded and non-traded goods $\kappa = 2.3$.

$\alpha^T = \alpha^N = 1$. As robustness check, we could consider two alternative cases. One (more realistic) in which the share of labor in the traded sector is higher relative to the traded one ($\alpha^N > \alpha^T$) and the opposite situation in which $\alpha^T > \alpha^N$. Intuitively when $\alpha^N > \alpha^T$, the relative marginal product of labor is lower in the traded sector and following a commodity price shock that increases the possibility of full de-industrialization and the delay in growth convergence relative to the baseline parametrization. Here we report two figures focusing on the case in which there is no endogenous growth. Fig. 11 corresponds to the case in which $\alpha^N = 1$ and $\alpha^T = 0.95$ (Case A), while Fig. 12 to the case in which $\alpha^T = 1$ and $\alpha^N = 0.66$ (Case B).

We note that under Case A, the commodity price shock triggers a permanent full de-industrialization which reinforces our analysis, while under Case B despite the larger difference in factor intensities we still have the same qualitative pattern as in our baseline parametrization.

A.2. Higher substitutability between traded and non-traded goods

In our baseline parametrization, we have considered the case in which traded and non-traded goods are complements ($\kappa = 0.75$). When the degree of substitutability increases, there is less need to shift resources towards the non-traded sector as the two goods become substitutes. This reduces the possibility of full de-industrialization and increases the speed of convergence relative to our baseline case. Fig. 13 shows the adjustment when $\kappa = 2.3$ (this would be the minimum level of substitutability above which there is no de-industrialization for our baseline parametrization). As we can see consumption and relative prices adjust immediately to the new long-run equilibrium since in the transition there is no full-deindustrialization.

Appendix B. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jinteco.2017.02.001.

References

Aghion, P., Howitt, P., 1992. A model of growth through creative destruction. Econometrica 60, 323–351.

Amiti, M., Konings, J., 2007. Trade liberalization, intermediate inputs, and productivity: evidence from Indonesia. Am. Econ. Rev. 97 (5), 1611–1638.

Benhabib, J., Spiegel, M.M., 2005. Human capital and technology diffusion. Handb. econ. growth 1, 935–966.

Benigno, G., Fornaro, L., 2014. The financial resource curse. Scand. J. Econ. 116 (1), 58–86.

Bergholt, D., 2014. Monetary policy in a oil-exporting economy. CAMP Working Paper

Bergholt, D., Larsen, V.H., 2016. Business cycles in an oil economy: lessons from Norway. Working Paper 2016/16, Norges Bank.

Bjørnland, H., 1998. The economic effects of North Sea oil on the manufacturing sector. Scott. J. Polit. Econ. 45 (5), 553–585.

Bjørnland, H., Thorsrud, L.A., 2016. Boom or gloom? Examining the Dutch disease in two-speed economies. Econ. J. 126, 2219–2256.

Blalock, G., Gertler, P.J., 2004. Learning from exporting revisited in a less developed setting. J. Dev. Econ. 75, 397–416.

Catao, L.A., Chang, R., 2015. World food prices and monetary policy. J. Monet. Econ. 75 (C), 69–88.

Coe, D.T., Helpman, E., Hoffmaister, A.W., 1997. North–South R&D spillovers. Econ. J. 107, 134–149.

Corden, M.W., Neary, J.P., 1982. Booming sector and de-industrialisation in a small open economy. Econ. J. 92, 825–848.

De Paoli, B., 2009. Monetary policy and welfare in a small open economy. J. Int. Econ. 77 (1), 11–22.

De Gregorio, J., Giovannini, A., Wolf, H., 1994. International evidence on tradables and nontradables inflation. Eur. Econ. Rev. 38, 1225–1244.

Duarte, M., Restuccia, D., 2010. The role of the structural transformation in aggregate productivity. Q. J. Econ. 125 (1), 129–173.

Erten, B., Ocampo, J.A., 2013. Super cycles of commodity prices since the mid-nineteenth century. World Dev. 44, 14–30.

Fernandez, A., Gonzalez, A., Rodriguez, D., 2015. Common factors in business cycles in emerging economies. IDB Working Paper 640.

García-Cicco, J., Kawamura, E., 2015. Dealing with the Dutch disease: fiscal rules and macro-prudential policies. J. Int. Money Financ. 55, 205–239.

Grossman, G.M., Helpman, E., 1991. Innovation and Growth in the Global Economy. MIT Press, Cambridge, MA.

Hamann, F., Bejarano, J., Rodríguez, D., 2015. Monetary Policy Implications for an Oil–Exporting Economy of Lower Long-Run International Oil Prices. Borradores de Economía. Banco de la República, pp. 871.

Hevia, C., Nicolini, J.P., 2015. Monetary policy and Dutch disease: the case of price and wage rigidity. Technical Report Federal Reserve Bank of Minneapolis.

IMF, 2015. World Economic Outlook.

Ismail, K., 2010. The structural manifestation of the 'Dutch disease': the case of oil exporting countries. IMF Working Papers pp. 1–36

Krugman, P., 1987. The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher: notes on trade in the presence of dynamic scale economies. J. Dev. Econ. 27 (1-2), 41–55.

Magud, N., Sosa, S., 2013. When and why worry about real exchange rate appreciation? The missing link between Dutch disease and growth. J. Int. Econ. Commer. Policy 4 (02), 1350009.

Manjón, M., Má nez, J.A., Rochina-Barrachina, M.E., Sanchis-Llopis, J.A., 2013. Reconsidering learning by exporting. Rev. World Econ. 149, 5–22.

Nelson, R.R., Phelps, E., 1966. Investment in humans, technological diffusion, and economic growth. Am. Econ. Rev. 56 (1/2), 69–75.

Parente, S.L., Prescott, E.C., 1994. Barriers to technology adoption and development. J. Polit. Econ. 102, 298–321.

Park, A., Yang, D., Shi, X., Jiang, Y., 2010. Exporting and firm performance: Chinese exporters and the Asian financial crisis. Rev. Econ. Stat. 92, 822–842.

Rodrik, D., 2013. Unconditional convergence in manufacturing. Q. J. Econ. 128 (1), 165–204.

Romer, P.M., 1986. Increasing returns and long-run growth. J. Polit. Econ. 94, 1002–1037.

Romer, P.M., 1990. Endogenous technological change. J. Polit. Econ. 98, 71–78.

Santacreu, A.M., 2015. Innovation, diffusion and trade: theory and measurement. J. Monet. Econ. 75, 1–20.

Spatafora, N., Warner, A.M., 1995. Macroeconomic Effects of Terms-of-Trade Shocks: The Case of Oil-Exporting Countries. 1410. World Bank Publications.

Torvik, R., 2001. Learning by doing and the Dutch disease. Eur. Econ. Rev. 45 (2), 285–306.

Van Biesebroeck, J., 2005. Exporting raises productivity in Sub-Saharan African manufacturing firms. J. Int. Econ. 67, 373–391.

Van der Ploeg, F., Venables, A.J., 2013. Absorbing a windfall of foreign exchange: Dutch disease dynamics. J. Dev. Econ. 103 (C), 229–243.

Van Wijnbergen, S., 1984. The Dutch disease: a disease after all? Econ. J. 94 (373), 41–55.