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Chapter 5

The Macroeconomic Impact of Deregulation in the European Services Sector

Summary

This chapter studies the implications of competition shocks. I show that a higher degree of competition in the non-tradables sector may have adverse implications for the tradables sector. I highlight four channels through which enhanced competition in the non-tradable goods sector affects the general price level in a large, open economy (lower monopoly rents, lower import prices, higher money demand, higher wages) and assess their relative importance algebraically. This chapter also analyses the impact of money shocks. I show that the long-run exchange rate magnification effect stressed by Hau (2000) is small.

5.1 Introduction

Europe is characterised by a relatively low degree of competition in goods and services markets when compared to the United States. Examples are general merchandising, construction, air passenger transport and road freight. But European policymakers make efforts to improve the situation. Initiatives by the European Commission promote the completion of a truly Single Market where monopolies, price agreements between suppliers and preferential treatment of domestic suppliers by governments are forbidden by law. Moreover, EU member states are, albeit sometimes hesitantly, liberalising their

network industries (telecom, energy, railways, water) and upgrading anti-trust legislation and enforcement. Liberalisation and anti-trust measures provide consumers with the possibility to choose a supplier on the basis of quality and price.

The question arises how the enhancement of competition in particular sectors affects the European economy at the macro level. Sector-specific deregulation is likely to lead to lower prices and higher output in the sector targeted by the competition authorities. But deregulation in one sector will have an impact on other sectors as well. For policymakers it is relevant to know how product market liberalisation in one, or several sectors affects aggregate output and the general price level. Taking an international perspective, how does an increase in the degree of competition in one sector affect the current account, the terms of trade and the exchange rate?

To address these questions, I employ the framework by Obstfeld and Rogoff (1995, 1996). Their model allows for imperfect competition, short-run nominal rigidities and rich exchange rate dynamics. Obstfeld and Rogoff's basic model is a two-country model with monopolistic competition and a single differentiated tradable good. A higher degree of substitutability between products corresponds to more competition (a lower degree of monopoly power for individual producers). Obstfeld and Rogoff also present a model with non-tradable goods and a single tradable good. There, they assume that individuals receive a fixed endowment of the tradable good and that the foreign price of the tradable good is fixed. An extension of their analysis is Hau (2000, 2002), who develops a two-sector, two-country model to study the relationship between trade openness and real exchange rate volatility. Hau uses a new representation of tradable and non-tradable goods, based on openness (the share of products which is traded internationally) rather than substitutability (the inclination of consumers to replace a product by another one in response to a price increase). In contrast to Obstfeld and Rogoff (1995, 1996), Hau's specification allows for prices and output of tradable goods to be determined endogenously. However, his specification implies that the tradable and non-tradable goods sectors must have an equal degree of competition and is thus rather restrictive from the perspective of price-formation.

The model in this chapter differs from Obstfeld-Rogoff (1995, 1996) and Hau (2000, 2002) in that it allows for different degrees of competition in different sectors of the economy. It distinguishes between tradable and non-tradable goods. It takes into account the fact that the degree of competition in non-tradables (services) markets tends to be lower than the degree of competition in tradable (goods) markets. This chapter also takes into account the sector-specific characteristic of competition-promoting measures. Since the degree of competition in many non-tradables markets is relatively low, these markets are priority fields of action for the competition authorities. Therefore, I focus
on the enhancement of the degree of competition in the European services sector. As
in Blanchard and Giavazzi (2001), the elasticity of substitution between products is
interpreted as an instrument of competition policy.

I obtain the following results. First, an increase in the degree of competition in
the non-tradable goods sector may have adverse implications for the tradables sector.
Intuitively, more competition in the non-tradables sector triggers an increase in labour
demand in the non-tradables sector, which causes a bidding up of wages and draws
labour from the tradable goods sector, leading to lower tradables output and a higher
price for tradables in the new equilibrium. The implication is that deregulating the
domestic services sector, via its impact on wages, will make a country less competitive
internationally.

Second, I highlight the existence of four channels through which an increase in the
degree of competition in the non-tradables sector may affect the general price level. Most
important is the direct effect via downward pressure on profits margins. Enhancing
competition in the non-tradables sector also has a downward impact on the general price
level via an improvement in the home country’s terms of trade and via an increase in
money demand (more competition enables households to consume more, which means
that real money balances have to increase). The fourth channel works in the other
direction: the expansion of output in the non-tradables sector leads firms to bid up
the wage rate, which increases labour costs and has an upward impact on the general
price level. I show that, for all realistic parameter values, an increase in the degree of
competition in the non-tradables sector reduces the general price level and raises overall
output and consumption in the domestic economy. This result is supportive of the Single
Market project and of the initiatives by EU national authorities to deregulate domestic
services markets. I provide an expression for the impact of enhanced competition on
the inflation rate in the transitional period between two steady states, which could
in principle be used by the European Central Bank (ECB) to derive the appropriate
temporary adjustment of its inflation objective.

The model also yields several interesting insights related to the exchange-rate impact
of money shocks. I confirm the presence of an ‘exchange rate magnification effect’ stressed
by Hau (2000, 2002). Hau shows that, for a relatively closed economy, changes in the
fundamentals will induce relatively large exchange rate fluctuations. I show that this
effect is quite small. The change in the exchange rate never exceeds the size of the
original shock to money. Thus, the exchange rate magnification effect would seem to be
unimportant in practice.

The remainder of this paper is organised as follows. In the next section, the basic
model is presented and equilibrium conditions under optimal behaviour by households
and firms are derived. In section 5.3, a log-linearised version of the model is presented. Section 5.4 analyses general dynamics. Section 5.5 analyses the impact of a permanent money shock. Section 5.6 studies the consequences of a permanent shock to the degree of competition. Section 5.7 concludes.

5.2 The model

5.2.1 Market structure and preferences

The world consists of two countries of identical size. Both countries are inhabited by a continuum of monopolistic producers. Producers in the Home country are indexed by $z \in [0, \frac{1}{2}]$, producers in the Foreign country are indexed by $z \in (\frac{1}{2}, 1]$. Each of them produces a single tradable good $z_T$ and a single non-tradable good $z_N$. The markets for tradable and non-tradable goods are characterised by monopolistic competition.

Household preferences are defined over an intertemporal utility function which includes a consumption index, real money balances and work effort:\(^2\)

$$U_t = \sum_{s=1}^{t} \beta^{s-t}[\log C_s + \chi \log\left(\frac{M_t}{P_s}\right) - \frac{\kappa}{2} L^2_s], \quad (5.1)$$

where $U$ is the lifetime utility of a representative Home household, $C$ is composite real consumption, $M$ is the amount of nominal money balances held by the representative household,\(^3\) $P$ is a consumption-based price deflator, $L$ is the amount of labour used in production, $\beta$ is the discount factor, $\chi$ is parameter associated with the utility derived from holding real money balances, $\kappa$ captures the disutility of work effort and $t, s$ are time subscripts. Time subscripts will be suppressed whenever possible. The mathematical expressions for Foreign variables are identical to those found for Home (apart from an asterisk (*) and a different indexation of producers) unless explicitly stated otherwise.

Composite real consumption in the Home country is given by

$$C = C_T^\gamma C_N^{1-\gamma}, \quad (5.2)$$

where $C_T$ is consumption of tradable goods. $C_N$ is consumption of non-tradable goods and $\gamma$ represents the relative preference of the representative household for tradable over

\(^2\)Consumption and money balances enter the utility function in log form. This implies a decreasing marginal utility derived from both. Utility is quadratic in labour effort (with a negative sign), implying an increasing marginal disutility from labour effort.

\(^3\)The money-in-the-utility function approach can be rationalised by arguing that real money balances allow agents to save time in conducting transactions [Warnock (1999)].
non-tradable goods.\footnote{This directly implies that the utility function is separable in tradable and non-tradable goods: \( \log C = \gamma \log C_T + (1 - \gamma) \log C_N \).}

Let \( c_N(z_N) \) \( [c_T(z_T)] \) be a Home household’s consumption of good \( z_N \) \( [z_T] \). Composite non-tradable goods consumption in the Home country \( C_N \) is defined by

\[
C_N = \left[ \int_0^1 \left[ c_N(z_N) \right]^{\theta_N^{-1}} dz_N \right]^{\frac{\theta_N}{\theta_N - 1}},
\]

(5.3)

where \( \theta_N \) is the degree of substitutability between non-tradable goods in the Home country. The degree of substitutability between Foreign non-tradable goods \( (\theta_N^* \) may differ from \( \theta_N \).

Tradable goods are sold in the world market. Composite tradable goods consumption in the Home country is defined by

\[
C_T = \left[ \int_0^1 \left[ c_T(z_T) \right]^{\theta_T^{-1}} dz_T \right]^{\frac{\theta_T}{\theta_T - 1}},
\]

(5.4)

where the degree of substitutability between all tradable goods is equal to \( \theta_T \), independently of where these goods are produced or consumed, i.e. \( \theta_T = \theta_T^* \). Each of the parameters \( \theta_T, \theta_N, \theta_N^* \) is assumed to be larger than one.\footnote{The parameters \( \theta_T, \theta_N, \theta_N^* \) will turn out to be the price elasticity of demand faced by each monopolist. Since marginal revenue of an additional unity of output is negative when the elasticity of demand is less than one, \( \theta > 1 \) is required to ensure a positive level of output in equilibrium.}

The variable \( P \) in the utility function (5.1) is a consumption-based price index (defined as the minimum money cost of purchasing one unit of composite real consumption \( C \)), here given by (see Appendix A for derivation):

\[
P = \left( \frac{P_T}{\gamma} \right)^{\gamma} \left( \frac{P_N}{1 - \gamma} \right)^{1 - \gamma},
\]

(5.5)

where \( P_T \) \( (P_N) \) is the consumption-based price index of tradable \( (\text{non-tradable}) \) goods in the Home country, given by

\[
P_T = \left[ \int_0^1 \left[ p_T(z_T) \right]^{1 - \theta_T} dz_T \right]^{\frac{1}{1 - \theta_T}}
\]

(5.6)

and

\[
P_N = \left[ \int_0^1 \left[ p_N(z_N) \right]^{1 - \theta_N} dz_N \right]^{\frac{1}{1 - \theta_N}}
\]

(5.7)
respectively, where \( p_T(z_T) \) is the money price of the tradable good \( z_T \) and \( p_N(z_N) \) is the money price of the non-tradable good \( z_N \).

There are no impediments to international trade, so that the law of one price holds for each individual tradable good:

\[
p_T(z_T) = Xp_T^*(z_T).
\]

where \( X \) is the nominal exchange rate, i.e. the price of one unit of Foreign currency expressed in the Home currency. Since both countries' residents have equal preferences, consumption baskets of tradable goods are equal across countries.\(^6\) Therefore, the law of one price (5.8) for tradable goods also holds at the aggregate level

\[
P_T = XP_T^*.
\]

Due to the existence of non-tradables in the model, purchasing power parity does not hold.

There is only one financial asset, an internationally traded riskless real bond denominated in the composite tradable consumption good. There is no capital in the model, so firm profits consist entirely of monopoly rents. It will be assumed that firms are entirely owned by households of the same country. Any firm profits are immediately handed back to the owners. Labour is immobile between countries, so that labour income remains in the own economy. The period budget constraint for a representative household of the Home country is

\[
P_{T,t}F_t + M_t = P_{T,t}(1 + r_{t-1})F_{t-1} + M_{t-1} + \\
+ W_tL_t + \Pi_t - P_{N,t}C_{N,t} - P_{T,t}C_{T,t} - P_{T,t}T_t.
\]

where \( F_t \) is the stock of bonds held by the representative household on date \( t \), \( r_{t-1} \) is the real interest rate on bonds between \( t - 1 \) and \( t \), \( W_t \) is the nominal wage rate, \( \Pi_t \) is firm profits and \( T_t \) is a lump-sum tax or transfer. Bonds and taxes are denominated in terms of the composite tradable good. The constraint (5.10) states that the households holdings of cash and bonds must be equal to the previous period's cash and bond holdings, increased by income from labour and ownership of firms and bonds, and reduced by

\(^6\)Equal preferences for tradables across Home and Foreign agents and a single degree of substitution for the entire tradables market (\( \theta_T \)) ensure that the composition of the tradable goods basket is equal in Home and Foreign. The possibility of different degrees of substitution in the non-tradables markets (\( \theta_N, \theta_N^* \)) does not affect the composition of the tradable goods baskets, since substitution between tradable and non-tradable goods takes place at a higher level of aggregation. The level of tradable goods consumption in Home and Foreign may differ, but this does not affect the results in this paper, which are derived from a linearisation around an initial equilibrium which is symmetric internationally.
spending on consumption and tax payments. Nominal wages exhibit short-run rigidity, but this will play no explicit role until section 5.4, where long-run and short-run dynamics are introduced.

It is assumed that the government budget is balanced at all times. Moreover, it is assumed that there is no government spending. All seigniorage revenues are redistributed in the form of transfers

\[ 0 = T_t + \frac{M_t - M_{t-1}}{P_t}. \]  

(5.11)

The nominal interest rate \( i_t \) is defined by

\[ 1 + i_t = (1 + r_t) \frac{P_{t,t+1}}{P_{t,t}}. \]  

(5.12)

### 5.2.2 Maximisation of household utility

The household’s maximisation problem can be separated in an intra-temporal and an intertemporal problem. The intra-temporal problem is solved first.

Maximising one-period composite real consumption \( C_T^{1-\gamma} C_N^{\gamma} \) subject to a nominal budget constraint yields the following expressions for composite tradable goods consumption and composite non-tradable goods consumption in the Home country (see Appendix A for the derivation)

\[ C_T = \left( \frac{\gamma P_N}{1 - \gamma P_T} \right)^{1-\gamma} C, \]  

(5.13)

\[ C_N = \left( \frac{1 - \gamma P_T}{\gamma P_N} \right)^{\gamma} C. \]  

(5.14)

which imply that households will spend more on the composite tradable good if preferences (\( \gamma \)) shift in favour of this good and if its relative price \( (P_T/P_N) \) declines. Mutatis mutandis, the same is true for the non-tradable good.

Similarly, Home demand for an individual tradable good \( z_T \) and non-tradable good \( z_N \) follows from maximising one-period composite tradable (non-tradable) consumption \( C_T \) (\( C_N \)), as defined in (5.3) and (5.4), subject to a nominal budget constraint [see Obstfeld-Rogoff (1996, p. 664) for a derivation]

\[ c_T(z_T) = \left( \frac{P_T(z_T)}{P_T} \right)^{-\theta_T} C_T, \]  

(5.15)

\[ c_N(z_N) = \left( \frac{P_N(z_N)}{P_N} \right)^{-\theta_N} C_N. \]  

(5.16)

\(^7\text{As Obstfeld and Rogoff (1995) point out, nothing is lost by this assumption, since Ricardian equivalence holds in this model.}\)
Demand for an individual tradable (non-tradable) good is decreasing in its relative price. The elasticity of substitution $\theta_T (\theta_N)$ turns out to be equal to the price elasticity of demand for each individual tradable (non-tradable) good.

World demand per capita for a particular non-tradable good is defined by equation (5.16). World demand per capita for a particular tradable good equals the average of Home and Foreign demand per capita for that good:

$$c^w_T(z_T) = \frac{1}{2} \left\{ \int_0^{1/2} [c_T(z_T)]_j dj + \int_1^{1/2} [c_T(z_T)]_j dj \right\} = \frac{1}{2} c_T(z_T) + \frac{1}{2} c_T^*(z_T) =$$

$$= \frac{1}{2} \left( \frac{p_T(z_T)}{P_T} \right)^{-\theta_T} C_T + \frac{1}{2} \left( \frac{p_T^*(z_T)}{P_T^*} \right)^{-\theta_T} C_T^* =$$

$$= \left( \frac{p_T(z_T)}{P_T} \right)^{-\theta_T} C_T^w. \quad (5.17)$$

where households are indexed $j$. The second equality follows from the symmetry of consumers and the final equality follows from (5.8) and (5.9). World per capita demand for the composite tradable good $C_T^w$ is defined as a weighted average (with equal weights in this particular case) of Home and Foreign per capita tradable goods consumption: $C_T^w = \frac{1}{2} C_T + \frac{1}{2} C_T^*$.  

Having solved the household's intra-temporal maximisation problem, I turn to the intertemporal problem. The representative household maximises life-time utility (5.1), subject to the period budget constraint (5.10) which must be satisfied in every single period. The first-order conditions are (see Appendix B for the derivation):

$$C_{T_{t+1}} = \beta (1 + r_t) C_{T_t}, \quad (5.18)$$
$$C_{N_{t+1}} = \beta (1 + r_t) \frac{P_{T_{t+1}}}{P_{T_t}} \frac{P_{N_{t+1}}}{P_{N_t}} C_{N_t}, \quad (5.19)$$
$$\frac{M_t}{P_t} = \lambda C_t \left( \frac{1 + i_t}{i_t} \right), \quad (5.20)$$
$$L_i^* = \frac{1}{\kappa} \frac{M_t}{P_t} \frac{1}{C_t}. \quad (5.21)$$

Equations (5.18)-(5.19) are the standard Euler equations for the consumption of tradable and non-tradable goods, respectively. They indicate how the consumption of tradable and non-tradable goods is smoothed over time. Equation (5.18) follows from the condition that the marginal utility from consuming tradable goods in period $t$ must equal the

\footnote{Recall that tradable goods production is for the world market, rather than for the domestic market. Therefore, equation (5.17), rather than (5.15), is the relevant demand constraint for the representative firm in the tradable goods market.}
(time-discounted) marginal utility from the amount of tradable goods that could have been consumed in period \( t + 1 \) when income had been saved (earning a real interest rate of \( r_t \)) in period \( t \). Equation (5.19) follows from the identical condition for non-tradable goods. The price indices in this equation serve to express the real interest rate in terms of the non-tradable good.\(^9\) The money demand equation (5.20) follows from the condition that the marginal utility derived from consumption in period \( t \) must be equal to the marginal utility derived from holding cash balances during that period and spending the resulting cash balances on consumption in period \( t + 1 \). The labour supply equation (5.21) is the result of the condition that the marginal utility from consuming the revenue earned from labour equals the marginal disutility of the corresponding labour effort.

\[ \text{Equation (5.19) also follows from combining (5.13)-(5.14) and (5.18). Therefore, this equation is superfluous and will not come back when solving the model in the next section.} \]

\[ \text{The assumption of competitive labour markets implies that firms and workers take the wage rate as given when making decisions on goods production (labour demand) and labour supply respectively.} \]

5.2.3 Maximisation of firm profits

The representative firm \( z \) is a monopolist in the production of a tradable good \( z_T \) and a non-tradable good \( z_N \). The firm uses only one input: labour. Labour is assumed to be homogeneous. The production processes for tradable and non-tradable goods are assumed to be identical, with constant returns to scale in production

\[
\begin{align*}
y_T(z_T) &= \alpha l_T(z_T), \\
y_N(z_N) &= \alpha l_N(z_N),
\end{align*}
\]

\[ \text{where } \alpha \text{ is labour productivity and } y_T(z_T) [y_N(z_N)] \text{ is output of good } z_T [z_N]. \] The goods markets clearing conditions, which will also be used to solve the firms' optimisation problem below, are

\[
\begin{align*}
y_T(z_T) &= c_T^w(z_T), \\
y_N(z_N) &= c_N(z_N).
\end{align*}
\]

The labour market is assumed to be competitive.\(^{10}\) It will be assumed that labour is immobile internationally, but fully mobile between sectors. It follows directly that wage levels in the tradable and non-tradable goods sectors will be equal in equilibrium, so there will be a single wage rate \( W (W^*) \) in each country. Therefore, nothing is lost by assuming that each representative household works in both sectors and it will not be necessary to explicitly divide labour income over two sectors.

\[ \text{\({}^{10}\)The assumption of competitive labour markets implies that firms and workers take the wage rate as given when making decisions on goods production (labour demand) and labour supply respectively.} \]
It is assumed that each firm produces a tradable and a non-tradable good. Assuming that each firm makes only one product would yield exactly the same results, since production processes and price setting for the two goods are entirely separated in each firm. The advantage of combining both production processes in one firm is that it allows me to present a single expression for profits, rather than separate expressions for profits in the tradables sector and in the non-tradables sector. The goods $z_T$ and $z_N$ are produced in a single firm $z$. Firm profits are

$$
\Pi(z) = p_T(z_T)g_T(z_T) + p_N(z_N)g_N(z_N) - Wl(z),
$$

where $l(z) = l_T(z_T) + l_N(z_N)$. The representative firm $z$ chooses $p_T(z_T)$ and $p_N(z_N)$ in order to maximise total profits (5.26), subject to the production functions (5.22)-(5.23), the demand functions for individual tradable and non-tradable goods (5.16) and (5.17) and clearing of goods markets (5.24)-(5.25). It is assumed that the firm takes aggregate demand for tradable and non-tradable goods ($C^w_T, C_N$) as given. The first-order conditions are (see Appendix C for the derivation):

$$
p_T(z_T) = \left(\frac{\theta_T}{\theta_T - 1}\right) \frac{W}{\alpha},
$$

$$
p_N(z_N) = \left(\frac{\theta_N}{\theta_N - 1}\right) \frac{W}{\alpha}.
$$

Equations (5.27)-(5.28) represent the optimal pricing rules for the representative firm. Product prices are set equal to unit labour costs plus mark-ups of $\frac{1}{\theta_T - 1}$ and $\frac{1}{\theta_N - 1}$ for tradable and non-tradable goods respectively. As the situation moves towards full competition (i.e. as the degrees of substitutability approach infinity), profit margins tend to zero.

The labour demand function can be derived using the production functions (5.22)-

11Recall that the absence of barriers in the tradable goods market implies that the law of one price holds for tradables, i.e. the firm cannot price discriminate between the domestic and the foreign market. In fact, it would even be sub-optimal for the firm to price-discriminate, given that the price-elasticities of tradables demand are equal in both countries. See also Obstfeld-Rogoff (1996, p. 711).

12Note that market power of firms in product markets drives a wedge between the product price and marginal production costs (which is equivalent to a wedge between the real wage and the marginal product of labour). This happens regardless of the degree of market power of workers. Market power of workers in the labour market drives a wedge between the marginal disutility of labour supply and the marginal utility of the consumption that additional labour supply buys at real factor prices. However, the degree of market power of workers does not affect the wedge between the marginal product of labour and the real wage [see Han (2000, p. 430)].
5.2. The model

(5.23):\(^{13}\)

\[ l^d(z) = \frac{1}{\alpha}[y_T(z_T) + y_N(z_N)]. \tag{5.29} \]

I will assume the labour market to clear in equilibrium. The labour market clearing condition for the Home country is:

\[ L^s = \int_0^1 l^d(z)dz, \tag{5.30} \]

with \(L^s\) as given by equation (5.21) and \(l^d\) given by equation (5.29).

Aggregate Home output is defined analogous to aggregate consumption

\[ Y = Y_T^\gamma Y_N^{1-\gamma}. \tag{5.31} \]

5.2.4 Competition policy

Following Blanchard and Giavazzi (2001), the elasticity of substitution between different varieties of the Home non-tradable good \((\theta_N)\) is interpreted as an instrument of competition policy.\(^{14}\)

Blanchard and Giavazzi (2001) consider product market deregulation along two dimensions: a reduction in entry costs and an increase in the price elasticity of demand. Intuitively, a government can promote competition by making it less costly for consumers to switch suppliers or via a reduction in entry costs. In the former case, product demand will become more responsive to differences in the product price, whereas in the latter case new firms will enter the market, offering the same product, but in a different variety or on a different location. In reality, many deregulations are likely to affect both the demand elasticity and entry costs. For instance, when deregulating the taxi market, the Dutch government increased the number of licenses (thus reducing the costs of market entry for firms) and relaxed the rules for choosing a taxi (thus lowering the switching costs for consumers).\(^{15}\)

\(^{13}\)Output of tradable and non-tradable goods must be aggregated through the formula for composite output [see equation (5.31)], but labour in both sectors is expressed in the same units and can be aggregated through straightforward addition.

\(^{14}\)The parameter \(\theta_N\) can be thought of as being a function of ‘deep parameters’ representing consumer preferences and competition policy. I assume that consumer preferences do not change over time, so that changes in \(\theta_N\) reflect changes in competition policy only.

\(^{15}\)As a result of the deregulation of the Dutch taxi market, customers are allowed to stop a taxi on the road, whereas before the deregulation they had to go to a designated taxi stop and accept the rate offered by the first taxi in line (or walk to the next stop).
In this paper, I analyse deregulation in the non-tradable goods sector. I do not distinguish between different types of competition-promoting government measures. Thus, I study a special case of the different possible forms of product market deregulation presented by Blanchard and Giavazzi (2001). All types of product market deregulation in this sector will be represented by a change in $\theta_N$.

It is important to note that an increase in the parameter $\theta_N$ does not have a direct impact on utility, even though $\theta_N$ appears in the utility function (via $C$). The symmetry among producers implies that, in equilibrium, households consume all varieties of the non-tradable good in equal proportions (the same is true for the tradable good):

$$\bar{C}_N = \left[ \frac{1}{2} \left[ \bar{c}_N(z_N) \right]^{\frac{\theta_{N-1}}{\theta_N}} dz_N \right]^{\frac{\theta_{N-1}}{\theta_N}} = \left[ \bar{c}_N(h) \right]^{\frac{\theta_{N-1}}{\theta_N}} \bar{c}_N^{\frac{\theta_{N-1}}{\theta_N}} = \bar{c}_N(h),$$

so that, from equations (5.1) and (5.2), a rise in $\theta_N$ does not augment utility directly. However, an increase in the elasticity of substitution between non-tradable products affects the elasticity of demand facing firms (which is also equal to $\theta_N$) and thus reduces the monopoly power of firms [see the pricing equation (5.28)]. This will, ceteris paribus, lead to lower prices and higher consumption. Thus, an increase in $\theta_N$ may affect utility via its impact on the monopoly power of firms.

5.3 Loglinearising the model

The model does not yield simple closed-form solutions, due to monopoly pricing and the endogeneity of output. Therefore, the model will be linearised around a symmetric steady state. The first step in this direction is deriving the solution for the initial symmetric steady state.

5.3.1 A symmetric steady state

In a steady state, all exogenous variables are constant. Steady-state values will be represented by overbars. It follows directly from (5.18) that real interest rate equality

$\theta_N$ is an important parameter in this paper, but it is implicitly assumed to be constant. In Blanchard and Giavazzi (2001), product market deregulation may increase or decrease the number of firms, depending on the mix of particular measures. An increase in the elasticity of demand leads to net exit of firms, whereas a reduction in entry costs leads to net entry of firms. For small changes in the elasticity of substitution, the number of firms remains constant when an increase in substitutability is accompanied by a proportional decline in entry costs. This is implicitly assumed here, but it will play no explicit role in the remainder of the paper.
holds across countries in the steady state.\(^\text{17}\) The steady state world real interest rate \(\bar{r}\) is\(^\text{18}\)
\[
\bar{r} = \frac{1 - \beta}{\beta}.
\] (5.32)

From the household budget constraint (5.10), it follows that steady state consumption is (see Appendix D for the derivation):
\[
\bar{C}_N = \bar{Y}_N, \quad (5.33)
\]
\[
\bar{C}_T = \bar{r} \bar{F} + \frac{\bar{P}_T^P}{\bar{P}_T} \bar{Y}_T, \quad (5.34)
\]

where \(\bar{P}_T^P\) is the production-based price index of tradable goods in the Home country and \(\bar{P}_T\) is the consumption-based price index of tradable goods in the Home country. The latter is affected not only by domestic producer prices \(\bar{P}_T^P\), but also by import prices (equivalent to exchange-rate adjusted Foreign producer prices) \(\bar{X}(\bar{P}_T^F)^*\).\(^\text{19}\)

In steady state, the current account must be balanced, but this is not necessarily the case for the trade account. Equation (5.34) shows that the Home country can run a trade deficit in steady state \((\bar{C}_T > \bar{Y}_T)\), but only if it owns interest-bearing net foreign assets or if it enjoys favourable terms of trade.\(^\text{20}\) See Appendix E for a discussion of the current account and trade account dynamics in this model.

Given that the model contains more endogenous variables than independent equations, there is still a multiplicity of solutions for the steady state. The starting condition of zero net foreign assets:
\[
\bar{F}_0 = 0,
\]
closes the model in the sense that the solution is now uniquely determined (see Appendix F).

---

\(^{17}\)Note that, because the law of one price holds for tradable goods at the aggregate level and because there is no uncertainty \((E_t X_{t+1} = X_{t+1})\), real interest rate equality \(r = r^*\) implies uncovered interest parity: \(1 + i_t = \frac{X_{t+1}}{X_t} (1 + i^*_t)\).

\(^{18}\)Equation (5.32) is equivalent to \(\beta = \frac{1}{1+i}\), showing that \(\beta\) is the usual discount factor.

\(^{19}\)Note that I have replaced \(p_T(h)\) and \(p_f(f)\) by \(\bar{P}_T^P\) and \((\bar{P}_T^F)^*\) respectively, in order to make clear that I am using aggregate variables. Recall that Home and Foreign consume all tradable goods, but that they produce a different set of tradable goods. Home produces the tradables indexed \([0, \frac{1}{2}]\), whereas Foreign produces the tradables indexed \((\frac{1}{2}, 1]\). This causes the consumption-based price index and the production-based price index to differ from each other in both countries.

\(^{20}\)Define the terms of trade as \(P_T^P/X(P_T^F)^*\). The terms of trade are favourable if export prices exceed import prices, i.e. if \(P_T^P > X(P_T^F)^*\). Recall that \(P_T = \frac{1}{2} P_T^P + \frac{1}{2} X(P_T^F)^*\). It follows directly that the terms of trade are favourable if \(P_T^P > P_T\), i.e. if domestic producer prices exceed domestic consumer prices.
In order to simplify the algebra, it is assumed that there is full international symmetry in the initial steady state. Thus, the price elasticities of demand for non-tradable goods are equal in the initial steady state, i.e. $\theta_N = \theta_N^*$. International symmetry also implies that the production-based price index of tradable goods is equal to the consumption-based price index of tradable goods: $(\bar{P}_T^p) = (\bar{P}_T)$.

It follows that the trade account is balanced in the initial steady state
\[(\bar{C}_T) = (\bar{Y}_T).\] (5.35)

Combining (5.21), (5.22)-(5.23), (5.27)-(5.28) and the final equation of Appendix A yields
\[
(\bar{Y}_T) = \frac{\alpha \gamma \left( \frac{\theta_T - 1}{\theta_T} \right)}{\kappa^{\frac{1}{2}} \left[ \gamma \left( \frac{\theta_T - 1}{\theta_T} \right) + (1 - \gamma) \left( \frac{\theta_N - 1}{\theta_N} \right) \right]^{\frac{1}{2}}}, \quad (\bar{Y}_N) = \frac{\alpha (1 - \gamma) \left( \frac{\theta_N - 1}{\theta_N} \right)}{\kappa^{\frac{1}{2}} \left[ \gamma \left( \frac{\theta_T - 1}{\theta_T} \right) + (1 - \gamma) \left( \frac{\theta_N - 1}{\theta_N} \right) \right]^{\frac{1}{2}}}. \] (5.36) (5.37)

Steady state output of tradable goods increases as the economy moves towards more competition in tradables ($\partial(\bar{Y}_T)/\partial \theta_T > 0$), whereas it decreases if the economy moves towards more competition in non-tradables ($\partial(\bar{Y}_T)/\partial \theta_N < 0$). Intuitively, an increase in competition in the non-tradables sector triggers an increase in labour demand from that sector, which causes a bidding up of real wages and draws labour from the tradable goods sector, leading to lower tradables output. The story is (mutatis mutandis) the same for steady state output of non-tradable goods.

From (5.36)-(5.37) and (5.31), the steady state level of output is
\[
\bar{Y}_T = \frac{\alpha \gamma \left( \frac{\theta_T - 1}{\theta_T} \right)^\gamma \left[ (1 - \gamma) \left( \frac{\theta_N - 1}{\theta_N} \right) \right]^{1-\gamma}}{\kappa^{\frac{1}{2}} \left[ \gamma \left( \frac{\theta_T - 1}{\theta_T} \right) + (1 - \gamma) \left( \frac{\theta_N - 1}{\theta_N} \right) \right]^{\frac{1}{2}}}. \] (5.38)

\[21\] I write $\theta_N = \theta_N^*$, rather than $(\theta_N) = (\theta_N^*)$, in order not to complicate notation. The assumption of international symmetry is not necessary to solve for the steady state, but it greatly simplifies the algebra. The elasticities of substitution for non-tradable goods will be allowed to move independently in the two countries (i.e. $\theta_N \neq \theta_N^*$).

\[22\] In the globally symmetric equilibrium, any two tradable goods produced anywhere in the world have the same price when measured in the same currency: $p(h) = X p(f)$. Aggregating over all tradable goods yields: $P_T^p = X(P_T^p)^*$. Combining with equation (5.6) yields: $P_T = \left\{ \frac{1}{2} (P_T^p)^{1-\theta_T} + \frac{1}{2} [X(P_T^p)^*]^{1-\theta_T} \right\}^{1/(1-\theta_T)} = P_T^p$. See Obstfeld and Rogoff (1996, p. 669).

\[23\] Recall that labour is assumed to be fully mobile across sectors. The increase in the real wage also triggers an increase in labour supply (see equation (5.43) below), but this is insufficient to accommodate the additional labour demand in the non-tradables sector.
In a model with tradables only ($\gamma = 1$), equation (5.38) simplifies to the formula reported by Obstfeld and Rogoff (1995), which corresponds to a similar result obtained earlier by Blanchard and Kiyotaki (1987) in a static closed economy framework:

$$Y_0 = \alpha \left( \frac{\theta_T - 1}{\kappa \theta_T} \right)^{\frac{1}{2}}.$$  

From equations (5.12), (5.20), (5.32) and the final equation of Appendix A

$$\begin{align*}
(\bar{P}_T)_0 &= \gamma \left( \frac{1 - \beta}{\chi} \right) \overline{M_0} \frac{1}{(\bar{Y}_T)_0}, \\
(\bar{P}_N)_0 &= (1 - \gamma) \left( \frac{1 - \beta}{\chi} \right) \overline{M_0} \frac{1}{(\bar{Y}_N)_0}.
\end{align*}$$

Equation (5.39) and (5.40) with the output equations (5.36)-(5.37). More competition in the tradables sector induces producers of tradable goods to cut prices and expand output. The higher labour demand in the tradables sector causes a bidding up of real wages and draws labour from the non-tradable goods sector, leading to lower non-tradables output and a higher price for non-tradables in the new equilibrium. Intuitively, enhanced competition in the tradables sector forces down profit margins in the tradables sector, but leads to higher real wages economy-wide.

---

24Obstfeld and Rogoff normalise their model such that (the inverse of) productivity is captured by the parameter $\kappa$. As a result, the parameter $\alpha$ does not appear in their equation.

25Recall that labour is mobile across sectors. If the degree of substitutability of labour across sectors were very low and the supply of labour inelastic, the increase in wages (as a result of the higher demand for labour) could lead to a rise in the price of tradables, despite a decline in the mark-up.

26In this model, enhanced competition in the tradables sector affects both countries symmetrically. In a model which allows for different degrees of competition in the domestic and foreign tradables sectors, enhancing competition in the domestic tradables sector implies a real appreciation of the Home currency. Note that this effect is quite similar to the Balassa-Samuelson effect (with enhanced competition in the tradables sector taking the place of higher productivity in the tradables sector).
Similarly, an increase in the degree of competition in the non-tradable goods sector leads to a decline in the price level in that sector, but to a rise in the price of tradable goods: \( \partial (\bar{P}_N) / \partial \theta_N < 0 \) and \( \partial (\bar{P}_T) / \partial \theta_N > 0 \). It follows directly that deregulating the domestic services sector (an increase in \( \theta_N \)) will make a country less competitive internationally. This will induce a nominal depreciation of the Home currency.

The real wage rate follows from equations (5.5) and (5.27)-(5.28):

\[
\frac{\bar{W}_0}{P_0} = \alpha \left[ \gamma \left( \frac{\theta_T - 1}{\theta_T} \right) \right]^{\gamma} \left[ (1 - \gamma) \left( \frac{\theta_N - 1}{\theta_N} \right) \right]^{1-\gamma}.
\]  

(5.42)

The real wage rate is increasing in the degree of competition in goods markets. Intuitively, competition pushes down goods prices, which induces a rise in consumption and output. The resulting increase in labour demand forces firms to bid up real wages.

Employment in the tradables and non-tradables sectors follow directly from equations (5.22)-(5.23). Adding up both sectors yields total employment

\[
\bar{L}_0 = \left( \frac{1}{\kappa} \right)^{\frac{1}{2}} \left[ \gamma \left( \frac{\theta_T - 1}{\theta_T} \right) + (1 - \gamma) \left( \frac{\theta_N - 1}{\theta_N} \right) \right]^{\frac{1}{2}}.
\]  

(5.43)

Overall employment is increasing in \( \theta_N \) and \( \theta_T \). A higher degree of competition in the tradables sector causes an expansion of output of tradables. The higher labour demand in the tradables sector will be partly drawn from the non-tradables sector and partly met by additional labour supply.

Using (5.22)-(5.23), (5.26), (5.27)-(5.28), (5.36)-(5.37), (5.41) and (5.42), real profits can be written as

\[
\frac{\bar{\Pi}_0}{\bar{P}_0} = \left[ \frac{\gamma}{\theta_T + \frac{1 - \gamma}{\theta_N}} \right] \bar{Y}_0.
\]  

(5.44)

Real profits increase when the level of turnover (i.e. aggregate output \( \bar{Y}_0 \)) increases, when the degree of competition \( (\theta_T, \theta_N) \) decreases and when consumer preferences \( (\gamma) \) shift in favour of the least competitive sector (i.e. in favour of the good with the lowest price elasticity of demand, which is the most profitable good to the firm).\(^{27}\)

### 5.3.2 Loglinearisation

To allow for asymmetries between the two countries, it is helpful to log-linearise the model around the initial steady state. Define \( \tilde{Z}_t = dZ_t / \tilde{Z}_0 \), that is variables with a hat denote percentage changes from the initial steady state.

\(^{27}\) The precise conditions are \( \partial (\bar{\Pi}_0 / \bar{P}_0) / \partial \gamma > 0 \), if \( \theta_T < \theta_N \) and \( \partial (\bar{\Pi}_0 / \bar{P}_0) / \partial (1 - \gamma) > 0 \), if \( \theta_N < \theta_T \).
The linearised price equations are:

$$
\hat{p}_N = -\frac{1}{\theta_N-1} \hat{\theta}_N + \hat{W}, \quad (5.45)
$$

$$
\hat{p}_T = -\frac{1}{\theta_T-1} \hat{\theta}_T + \frac{1}{2}(\hat{W} + \hat{W}^*) + \frac{1}{2} \hat{X}, \quad (5.46)
$$

$$
\hat{p}_N^* = -\frac{1}{\theta_N-1} \hat{\theta}_N^* + \hat{W}^*, \quad (5.47)
$$

$$
\hat{p}_T^* = -\frac{1}{\theta_T-1} \hat{\theta}_T^* + \frac{1}{2}(\hat{W} + \hat{W}^*) - \frac{1}{2} \hat{X}. \quad (5.48)
$$

An increase in the degree of competition ($\theta$) in a certain sector leads to a decline of producer prices in that sector. The lower the initial degree of competition (i.e. the higher $\frac{1}{\theta-1}$), the larger the price impact of enhanced competition. A rise in the wage rate at Home leads to a proportional increase in the non-tradable consumer price subindex in the Home country and to a less than proportional increase in the tradable consumer price subindex in Home and Foreign. An exchange rate movement has an opposite impact on the price of tradables in the two countries.

Taking total differentials of equation (5.29) and using equations (5.36)-(5.37), (5.43), the linearised version of (5.15)-(5.16) and the goods market clearing conditions gives

$$
\hat{L} = \phi_T \hat{Y}_T + \phi_N \hat{Y}_N, \quad (5.49)
$$

where

$$
\phi_T = \frac{\gamma(\frac{\theta_T-1}{\theta_T})}{\gamma(\frac{\theta_T-1}{\theta_T}) + (1-\gamma)(\frac{\theta_N-1}{\theta_N})}, \quad \phi_N = \frac{(1-\gamma)(\frac{\theta_N-1}{\theta_N})}{\gamma(\frac{\theta_T-1}{\theta_T}) + (1-\gamma)(\frac{\theta_N-1}{\theta_N})}.
$$

Note that $\phi_T + \phi_N = 1$. When $\theta_T = \theta_N$, the expressions simplify to $\phi_T = \gamma$ and $\phi_N = 1 - \gamma$. The full linearised model is reported in appendix G.

### 5.4 Dynamics

This section discusses the model dynamics. Going through the general dynamics is helpful before studying the impact of a permanent exogenous money shock in the Home country (section 5.5) and a permanent exogenous shock to the degree of competition in the Home country (section 5.6).

I will assume a shock takes place at $t-1$, when the economy is in the initial steady state. In order to follow the dynamics of the economy after the shock, I will distinguish
between the short run and long run. Wages are assumed to be fixed for one period (going from \( t - 1 \) to the short-run equilibrium in \( t \)) and fully flexible thereafter. As in Obstfeld-Rogoff (1995), the economy reaches its long-run equilibrium in \( t + 1 \) and remains in this new steady state thereafter. Thus, there is no staggered price setting as in Calvo (1983). Shocks are assumed to be small. Therefore, by assumption, both the short-run equilibrium and the new long-run steady state are sufficiently close to the initial steady state to justify a linear approximation of the model.

I will first discuss the characteristics of the new long-run equilibrium, then turn to the short-run dynamics and highlight the role of international wealth transfers in connecting the short and long run.

5.4.1 Comparing steady states

The long-run equilibrium is a steady state. The long-run real interest rate must be constant. Its level is given by equation (5.32), as in the initial steady state. Since all prices are constant in the steady state, it follows directly from equation (5.12) that the long-run nominal interest rate is equal to the real interest rate and must therefore be constant too (i.e. \( \hat{\pi} = \hat{i} = 0 \)). Long-run steady state changes are indicated by variables with an overbar and a hat.

Lead the linearised version of equation (5.20) by one period and recall that the economy is in steady state as of \( t + 1 \). Therefore, both \((t + 1)\)-subscripted and \((t + 2)\)-subscripted variables can be replaced by steady state changes. After simplifying, the long run steady state path money demand is given by:

\[
\hat{M} - \hat{P} = \hat{C}.
\]

Combining equation (5.50) with the linearised versions of (5.5) and (5.8) yields the expression for the long-run exchange rate:

\[
\hat{X} = \frac{1}{\gamma} \hat{\frac{M}{M}} - \frac{1}{\gamma} \hat{\frac{C}{C}} - \frac{1 - \gamma}{\gamma} \hat{\frac{P}{P}}_N.
\]

where a superscript \( d \) indicates the difference between Home and Foreign, e.g. \( \frac{M}{M}^d = \hat{M} - \hat{M}^* \). The expression illustrates the 'exchange rate magnification effect' stressed by Hau (2000, 2002): if the size of the tradables sector \((\gamma)\) is small, changes in the fundamentals \((M, C)\) will induce relatively large exchange rate fluctuations, even in the long run. Hau (2002) provides empirical support for an inverse relationship between openness and exchange rate volatility. The intuition given by Hau is that for an economy
5.4. Dynamics

with fewer tradables, price level adjustment will require larger changes in the exchange rate. It is easy to check that in my model the size of the exchange rate movement (\( \hat{X} \)) is also decreasing in the size of the tradable goods sector. However, as shown by equation (5.51), the non-tradables price differential (the third term on the right-hand side) may absorb part of the shock to money or consumption. It is easy to show that, even for a very closed economy (\( \gamma \to 0 \)), the size of the exchange-rate response never exceeds the size of the shock to money or competition (i.e. \( \hat{X} < \hat{M} \) and \( \hat{X} < \hat{d}^d_N \)). Thus, the exchange rate magnification effect is limited in size (see appendix J).

5.4.2 Short-run equilibrium

Recall that the economy encounters a shock at time \( t - 1 \). The short run (the period running from \( t - 1 \) to \( t \)) is characterised by sticky wages (i.e. \( \hat{W} = \hat{W}^* = 0 \)). However, the mark-up for non-tradable goods can change as a result of competition policy. Thus, in this model, contrary to Obstfeld and Rogoff (1995, 1996) and Hau (2000, 2002), wage rigidity does not imply price rigidity per se, i.e. short-run non-tradables price changes (\( \hat{P}_N \)) need not be zero. The short run can be seen as a transition period, before the economy reaches its long-run equilibrium. Recall that short-run percentage changes are indicated by hatted variables without time subscripts or overbars.

Since the short-run equilibrium is not a steady state, the real interest rate need not be constant. Also, the short-run price level need not be equal to the long-run price level. Output is demand-determined in the short run. Therefore, short-run unemployment or labour shortages can occur.\(^{28}\)

The short-run change in the exchange rate is equal to the long-run change, i.e. the exchange rate immediately jumps to its long-run value (\( \hat{X} = \hat{X} \), see appendix J).

5.4.3 International wealth transfers

International wealth transfers play an essential role in the model’s dynamics. In particular, a temporary shock may affect the long run equilibrium via its impact on the international distribution of wealth. International wealth transfers are endogenously determined in the short run. I will discuss the impact of exogenous wealth transfers on the long-run equilibrium here, before solving the model explicitly for shocks to the money

\(^{28}\)Technically, the labour-leisure condition [the linearised version of equation (5.21)] determines labour supply, but not the actual level of employment, which is determined by the labour-demand equation [the linearised version of (5.29)].
supply and the degree of competition (which cause international wealth transfers) in the following sections.

The model's symmetry admits a simple solution approach. I first solve for differences between Home and Foreign variables and then for world aggregates. This approach also provides a better insight in the underlying intuition.

From the linearised versions of equations (5.33)-(5.34):

\[
\hat{C}^d = 2\gamma \frac{\bar{r}d\bar{F}}{(C^w_T)_0} + \hat{Y}^d + \gamma \{(\hat{P}_T^p)^d - \hat{X}\}. \tag{5.52}
\]

If output were exogenous (i.e. when labour input were fixed), a wealth transfer equal to 1 unit of tradable goods to the Home country would lead to a steady-state international consumption differential of \(2\gamma\bar{r}\): Home residents would raise consumption by the interest \(\gamma\bar{r}\) on the transfer and Foreign residents would reduce consumption by \(\gamma\bar{r}\). However, output is endogenous in this model: the net wealth transfer leads Home residents to work less and enjoy more leisure. Foreign country residents do the opposite, leading to the following (negative) international output differential:

\[
\hat{Y}^d = (\phi_T - 2\gamma) \frac{\bar{r}d\bar{F}}{(C^w_T)_0}. \tag{5.53}
\]

The endogeneity of output causes the consumption differential between Home and Foreign to be smaller than \(2\gamma\bar{r}d\bar{F}/(C^w_T)_0\).

Home's long-run terms of trade, given by

\[
(\hat{P}_T^p)^d - \hat{X} = \frac{1 + \phi_N}{\theta_T} \frac{\bar{r}d\bar{F}}{(C^w_T)_0}. \tag{5.54}
\]

improve when Home receives a transfer. This improvement is also driven by the labour-leisure decision. The Home country residents' decision to work less reduces Home output and therefore has an upward effect on domestic producer prices, which improves the terms

\footnote{Recall that the internationally traded riskless real bond is denominated in terms of the composite tradable consumption good. A wealth tranfer which enables a 1 percent increase in consumption of the tradable good enables a \(\gamma\) percent increase in consumption of the composite good.}

\footnote{For \(\phi_T < 2\gamma\) to hold, it is sufficient that \(\theta_N > 2(1 - \gamma)\). See appendix I. As will be argued in section 5.6, this condition is satisfied in practice.}

\footnote{This is in line with the well-known argument by Keynes that a country making international transfer payments will experience a deterioration in its terms of trade. See, for instance, Obstfeld and Rogoff (1996, p. 255).}
5.5. Money shocks

This section studies the macroeconomic effects of money shocks. More specifically, I look at the impact of an unanticipated permanent increase in the Home money supply, i.e. \( \Delta \tilde{M} = \tilde{M} \). Since shocks are additive, we may temporarily set \( \tilde{\theta}_T = \tilde{\theta}_N = \tilde{\theta}_N = 0 \) and then solve for the endogenous variables as functions of the money shock.

5.5.1 Long-run impact

One implication for monetary policy follows directly from the previous subsection. As will be seen when discussing the short-run dynamics below, an expansion of the Home money supply induces a short-run current account surplus for the Home country, which is balanced by a net transfer of financial assets from the Foreign country to the Home country \( (d \tilde{F} > 0) \). Substituting equations (5.53)-(5.54) into equation (5.52) yields:

\[
\frac{\dot{c}}{C} = \left[ \phi_T + \frac{\gamma(1 + \phi_N)}{\theta_T} \right] \frac{\tilde{r}d\tilde{F}}{(C_T)_0}. \tag{5.55}
\]

It is easily seen that the resulting international consumption differential is positive and smaller than \( 2\tilde{r}d\tilde{F}/(C_T)_0 \). Thus, a money supply shock, via the wealth effect, has an upward effect on the long-run consumption differential. In other words, money has real effects in the long run.\(^{34}\)

Obstfeld-Rogoff (1996, p. 690) present a model which includes non-tradables. In their model, the Home country is small, the tradable goods sector is perfectly competitive and Home output of the tradable good is exogenous. The small-country assumption

\[^{32}\text{Optimal pricing by firms implies that export prices are equal to domestic producer prices for tradable goods} (P^X = P^F) \text{ and that import prices (foreign export prices) are equal to foreign producer prices expressed in the domestic currency} (P^M = X(P^F)^*) \text{. Then the terms of trade can be expressed as} P^X/P^M = P^F/(X(P^F)^*) \text{. Thus, an increase of domestic producer prices leads to an improvement in the terms of trade. See also footnote 20.} \]

\[^{33}\text{Recall that} \theta_T > 1 \text{ and} \gamma < 1 \text{. If both parameters were equal to 1, the expression would reduce to} \phi_T + 1 + \phi_N, \text{ which is equal to 2.} \]

\[^{34}\text{The long-run effect of money on consumption should not be overstated. It is in the order of magnitude of the real interest rate, since it is caused by the yield on net foreign assets (which the Home country has accumulated as a result of its short run current account surplus).} \]
implies that Home producers must be price-takers and that the tradables sector must be perfectly competitive. As seen in the previous section, the latter implies that the terms of trade are constant. Since Obstfeld-Rogoff also assume that the Home country has a fixed endowment of the tradable good in each period and zero net foreign assets in the initial steady state and that the utility function is separable in tradable and non-tradable goods, domestic supply and demand of the tradable good will always be equal. Thus, there are no current account effects and money loses its non-neutrality property when Obstfeld-Rogoff include non-tradables in their model. I do not make the small country assumption and I allow output in both sectors to be endogenously determined. As a result, contrary to Obstfeld-Rogoff (1996), money retains its non-neutrality property in the presence of non-tradables in my model.35

Look at the international CPI differential. Combining equations (5.50) and (5.55) yields:

\[ \hat{P}_d = \hat{M}_d - [\phi_T + \frac{\gamma(1 + \phi_N)}{\theta_T}] \frac{\bar{v}}{\bar{C}_T} \]  

(5.56)

The wealth effect which causes money to have a positive impact on the long-run real consumption differential, also implies that the long-run CPI differential changes less than proportionately to a permanent money shock: \( \hat{P}_d < \hat{M}_d \).

Next, I turn to world aggregates. From the linearised versions of equations (5.5), (5.21), (5.27)-(5.28), (5.33)-(5.34) and the corresponding equations for the Foreign country, it follows that

\[ \hat{Y}_w = \hat{C}_w = 0. \]  

(5.57)

Money is neutral at the world level in the long run. Combining this result with the money demand equation (5.50) and its Foreign counterpart immediately yields:

\[ \hat{P}_w = \hat{M}_w. \]  

(5.58)

Money shocks will translate one-for-one into price increases at the world level.36

35This paper studies exogenous money supply shocks. If monetary policy is determined endogenously in a model with rational expectations then, in equilibrium, the monetary authorities cannot systematically raise output, but they can help to stabilise the economy in response to unanticipated shocks (Obstfeld and Rogoff, 1996, p. 684).

36Money is neutral at the world level, but may affect country differences. This result corresponds to the notion that monetary policy can become beggar-thy-neighbour (see chapters 2 and 3).
5.5.2 Short-run impact

Next, turn to the short run. Recall that I consider the impact of an unanticipated permanent shock to the money supply. The short-run stickiness of wages ($\hat{W} = \hat{W}^* = 0$) implies that the short-run world price level is not affected by changes in the money supply:

$$\hat{P}_w = 0.$$  \hfill (5.59)

The expressions for world output, world consumption and the world interest rate are (see Appendix H for derivation):

$$\hat{Y}_w = \hat{C}_w = \hat{M}_w,$$

$$\hat{r} = -(1 + \frac{1}{\hat{r}})\hat{M}_w,$$  \hfill (5.60, 5.61)

In the short run, wages cannot adjust to money shocks. As a result, monetary policy is able to affect output and consumption. In this model, a one percent increase in the world money supply leads to a one percent increase in world output and consumption.

An increase in the world money supply leads to a decline in the world real interest rate.

As a result of the short-run stickiness of nominal wages, the short-run impact of monetary policy on output exceeds its long-run impact. The real interest rate must decline in order to induce a similar time-pattern for world consumption (via lower savings).

Next, turn to international differences:

$$\hat{C}_d = \left[1 - \frac{\gamma}{\theta_T} \left(1 + \frac{2(\theta_T - 1)}{D}\right)\right] \hat{M}_d,$$

$$\hat{Y}_d = \left[1 + \frac{2\gamma(\theta_T - 1)}{D}\right] \hat{M}_d.$$

where $D = 2 + \hat{r}(1 + \phi_N + \phi_T \theta_T)$. Under monopolistic competition, prices are set above the marginal cost of production. Therefore, at the margin, it is profitable for firms to accommodate additional demand by producing more output.$^{37}$ This means that output becomes demand-determined when wages are rigid. As will be seen below, a Home money expansion causes a depreciation of the Home currency ($\hat{X} > 0$). This induces net Foreign demand for Home goods ($\hat{Y}_d > \hat{C}_d$).$^{38}$

$^{37}$As stated, this is only true at the margin, i.e. for small increases in demand. See Blanchard and Kiyotaki (1987).

$^{38}$Recall that net Foreign demand falls entirely on tradable goods (i.e. $\hat{Y}_d > \hat{C}_d$). Since the markets for non-tradable goods clear within each country, it follows that $\hat{Y}_d = \hat{C}_d$. Combining these two equations implies $\hat{Y}_d = \hat{C}_d$. It is easy to show that $(1 - \gamma)\hat{M}_d < \hat{C}_d < \hat{M}_d < \hat{Y}_d < [\gamma \theta_T + (1 - \gamma)]\hat{M}_d$ for all admissible parameter values.
Given that wages are all fixed in the short run, the world price level cannot change either, as shown above. However, exchange rate movements may cause a change in relative prices:

\[ \tilde{P}^d = \gamma \tilde{X}. \] (5.64)

### 5.5.3 Exchange rate and current account

As in Obstfeld and Rogoff's (1995) model with tradables only, the exchange rate immediately jumps to its new long-run equilibrium value (\( \tilde{X} = \tilde{X} \)).

The reduced-form solution for the exchange rate is:

\[ \tilde{X} = \frac{2\theta_T + \bar{r}(1 + \phi_N + \phi_T\bar{r})}{2\theta_T + \theta_T\bar{r}(1 + \phi_N + \phi_T\bar{r})} \tilde{M}^d. \]

A permanent monetary expansion in Home leads to a depreciation of the Home currency (\( \tilde{X} > 0 \)). The change in the exchange rate is less than proportional to the size of the money shock (\( \tilde{X} < \tilde{M}^d \)). As seen in the previous section, a smaller tradable goods sector leads to a higher long-run exchange rate response to money shocks, but the response coefficient is always below unity, so that the exchange rate magnification effect is unimportant in this model.

In the special case when the tradable goods sector is characterised by perfect competition (\( \theta_T \to \infty \)), the expression for the exchange rate reduces to \( \tilde{X} = 0 \). The intuition is that the Home country is a price taker in the tradable goods market and it cannot allow a change in the exchange rate without severely distorting its economy.

Wage rigidity implies that domestic producer prices will not be affected by money shocks in the short run. Therefore, the short-run terms of trade are fully determined by the short-run exchange rate (with a minus sign, as an appreciation of the Foreign currency, \( \tilde{X} > 0 \), induces a deterioration of the Home terms of trade):

\[ \tilde{P}_T^p - (\tilde{P}_T^p)^* - \tilde{X} = -\tilde{X}. \] (5.65)

The short-run current account (which equals the change in net foreign assets) has the following reduced-form solution (see Appendix H):

\[ \frac{d\tilde{F}}{(\tilde{C}_T^w)_0} = \frac{\theta_T - 1}{2 + \bar{r}(1 + \phi_N + \phi_T\bar{r})} \tilde{M}^d. \] (5.66)

An expansion of the Home money supply leads to a short-run surplus on the current account.

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39 This is due to the fact that the only shock here is a money shock. In the next section, when shocks to competition are considered, prices can change in the short run, despite short-run nominal wage rigidity.
5.6 Product market deregulation

This section studies the impact of product market deregulation in the shielded sector, where the degree of competition is typically lower than in the open sector. More precisely, I focus on permanent shocks to the degree of competition in the Home non-tradable goods sector (i.e. $\hat{\theta}_N = 0$). In this section, I will set $\hat{M} = M^* = 0$ (no money shocks).

5.6.1 Long-run impact

As in the previous section, I start with the long-run equilibrium. In a closed economy, the direct impact of a positive shock to the degree of competition can be decomposed in an income and a substitution effect. First, enhanced competition reduces the mark-up in the non-tradables sector. The resulting decline in the price of non-tradables has an upward effect on the real wage, which effectively increases demand for both type of products. Secondly, the decline in the relative price of non-tradables causes a demand shift from tradables to non-tradables. The two effects combined have the following impact on tradables and non-tradables output:

$$\tilde{Y}_T^d = \frac{\phi_N}{2(\theta_N - 1)} - \frac{\phi_N}{\theta_N - 1} \tilde{\theta}_N < 0,$$
$$\tilde{Y}_N^d = \frac{-\phi_N}{2(\theta_N - 1)} + \frac{\phi_T}{\theta_N - 1} \tilde{\theta}_N > 0,$$

where the first term on the right-hand side represents the increase in overall demand (equal for both sectors) and the second term on the right-hand side represents the demand shift (negative for the tradables sector and positive for the non-tradables sector). For the non-tradables sector, the two effects re-inforce each other. However, for the tradables sector, the substitution effect dominates the income effect. Thus, product market deregulation leads to an expansion of output in the targeted sector, but an output decline in the other sector.

Recall that the formulas refer to the percentage change in output. The additional product demand caused by the income effect is divided over the different sectors in proportion to the size of the sectors, which leads to equal percentage changes. The increase in aggregate demand will be larger if competition is low, initially ($\theta_N$ small), so that enhancing competition will have a more significant downward impact on the mark-up and if the non-tradables sector is large ($1 - \gamma$ large, and thus $\phi_N$ large), so that the price reduction of non-tradables has a relatively large impact on the general price level.

The demand shift is larger if the initial degree of competition is low ($\theta_N$ small), so that enhancing competition will cause a large decline in the relative price of non-tradables. The impact of the demand shift on the individual sectors is inversely related to the size of the sector concerned (as reflected by $\phi_N$ in the formula for tradables output and $\phi_T$ in the formula for non-tradables output).
The expression for aggregate output in an open economy is:

\[
\frac{\tilde{Y}^d}{\tilde{Y}} = \left(1 - \gamma \right) - \frac{\phi_N}{2(\theta_N - 1)} \tilde{\theta}_N^q + (\phi_T - 2\gamma) \frac{\tilde{r}dF}{\tilde{C}_T}. \tag{5.67}
\]

The coefficient of \(\tilde{\theta}_N\) is the (weighted) sum of the tradables and non-tradables output. From the perspective of the firm, the decline in monopoly power in the non-tradables sector causes additional consumer demand, which makes it attractive to produce more output \((\frac{1}{\tilde{\theta}_N - 1})\), whereas the higher real wage rate makes labour more expensive, which has a negative impact on labour demand and output \((-\frac{\phi_N}{2(\tilde{\theta}_N - 1)}\)). Product market deregulation causes a positive wealth effect \((dF > 0, as will be seen below), which induces Home residents to work less and therefore has a negative effect on Home output. This means that the overall effect on Home output is a priori ambiguous.

Realistically, the following constraints may be imposed on the parameters. First, the degree of competition in the world market for tradable goods is larger than in the domestic markets for non-tradable goods, i.e. \(\theta_T > \theta_N\). This is in line with Hakura (1998), who empirically finds that both import and export penetration have a significant negative impact on the price-cost margins. Second, the price-elasticity of demand in the non-tradables goods market satisfies the condition \(\theta_N > 2\). This follows from Neiss (2001), who finds an average labour income share in GDP of 50% for OECD countries. Most empirical papers find results that correspond to a price-elasticity of demand \((\theta)\) in a range between 3.5 and 6. This corresponds to an average mark-up \([1/(\theta - 1)]\) of 20-40%. See Obstfeld and Rogoff (2000) for references. Third, the share of tradables is less than 50% of output, i.e. \(\gamma < \frac{1}{2}\). In fact, for Europe, the share of agriculture and industry (which typically produce tradable goods) in total output is some 25%, whereas the share of (mostly non-tradable) services is some 75%.

For these realistic values of the model parameters \((\theta_T > \theta_N > 2; \gamma < \frac{1}{2})\), the direct effect on output (lower monopoly rents) will dominate the indirect effect (higher real wage), so that an increase in the degree of competition in the non-tradables sector raises overall output in the domestic economy. This result is supportive of the Single Market project and of initiatives by EU national authorities to deregulate domestic services markets.

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The substitution effect does not cancel out at the aggregate output level, even though it does so at the aggregate employment level. The reason is that the weights of the non-tradables and tradables sectors in output \((\gamma, 1 - \gamma)\) can be (slightly) different from the sector weights in employment \((\phi_T, \phi_N)\).

Labour income gives a lower bound for firm production costs, whereas GDP gives an upper bound for firm sales. If production costs are at least 50% of firm sales, then the average profit margin is not more than 100% of production costs, i.e. \(\tilde{\phi}_N - 1 < 1\), which is equivalent to \(\theta_N > 2\).
If competition authorities target the wrong sector [i.e. if they enhance competition in the tradables sector, despite that this sector is relatively unimportant (γ small) and competition in the other (non-tradables) sector is very limited (θ_N very small)], adverse output effects may occur. In this case, the output decline in the non-tradables sector may outweigh the output rise in the tradables sector. The implication is that further deregulating the tradables sector may be unattractive for countries with a highly protected non-tradables sector. However, this possibility only occurs for implausible parameter values.\footnote{The sectors differ in the degree of competition. Therefore, even though labour productivity is equal in both sectors, adding labour generates higher revenues to firms in a sector with a lower degree of product market competition. Intuitively, if competition authorities target the ‘wrong’ sector (i.e. if the other, non-targeted sector has a particular lack of competition), then the shift of labour may reduce overall firm profits so much that this outweighs the increase in total labour income. Numerically, if γ = 0.25 (corresponding to the joint share of industry and agriculture in the gross domestic product in the US and Europe) then output is increasing in the degree of competitiveness in the tradables sector only if the degree of competitiveness in the non-tradables sector satisfies \( \theta_N > 1.5 \). If γ = 0.1 (corresponding to the share of exports in the US gross domestic product, the share is somewhat higher for Europe) then output is increasing in the degree of competitiveness in the tradables sector only if \( \theta_N > 1.7 \).}

The Home country long-run terms of trade, given by

\[
\hat{T_{OT}} = \hat{P}_T - (\hat{P}_T)^* - \hat{X} = \frac{\phi_N}{2\theta_T(\theta_N - 1)} \hat{\theta}_N + \frac{1 + \phi_N}{\theta_T} \frac{\tilde{r}_d F}{(C_T)^0},
\]

improve when competition in the Home non-tradables sector is enhanced. The reason is that the relative scarcity of labour (even with the additional supply) leads firms to bid up the wage rate, so that the price of domestic tradables increases.

Substituting the last two equations into equation (5.52) yields:

\[
\hat{C}_d = [(1 - \gamma) + \frac{\gamma \phi_N}{2\theta_T} - \frac{\phi_N}{\theta_N - 1}] \hat{\theta}_N + \frac{\phi_N}{\theta_T} \frac{\tilde{r}_d F}{(C_T)^0} [\phi_T + \frac{\gamma(1 + \phi_N)}{\theta_T}].
\]

The international consumption differential is almost surely positive.

Now we turn to prices. In a closed economy, enhancing competition has the following impact on tradables and non-tradables prices:

\[
\hat{P}_N^d = \left[ -\frac{1}{\theta_N - 1} + \frac{\phi_N}{2(\theta_N - 1)} \right] \hat{\theta}_N < 0,
\]

\[
\hat{P}_T^d = \frac{\phi_N}{2(\theta_N - 1)} \hat{\theta}_N > 0.
\]
The downward impact of higher non-tradables competition on the mark-up for non-tradable goods is the first term in the expression for $\hat{P}_N^d$. The additional labour demand in the non-tradables sector results in a higher wage rate in the entire economy, as labour is mobile across sectors. This is the positive term common to both expressions.

Only little research has been conducted on the impact of sector-specific competition shocks on the price of goods in other sectors. ECB (2001a) suggests that this indirect price effect is likely to be negative, insofar as inputs for other sectors become cheaper. For instance, deregulation in the energy sector will lower the electricity costs for companies in other sectors. There are no intermediate goods in the present model. Instead, I stress that deregulation in one sector will increase the wage costs for companies in other sectors. Whether or not the increase in labour costs (the 'wage bill') is indeed more important than the decline in the price of intermediate goods (the 'electricity bill') is an empirical matter that will not be addressed here.

Combining equations (5.50) and (5.68) yields the aggregate international CPI differential:

$$\hat{P}^d = \left[ -\frac{1}{\theta_N-1} + \frac{\phi_N}{2(\theta_N-1)} \right] \hat{\theta}_N - \gamma \overline{TOT} - \phi_T \hat{dF}_T \left( \frac{C}{T} \right)_0 .$$

Equation (5.69) shows four channels through which enhanced competition in the Home country ($\theta_N > 0$) affects the general price level. First, enhanced competition in the non-tradables sector has a downward impact on monopoly profits in this sector, which lowers the price of non-tradables goods. The impact on the general price level is proportional to the size of the non-tradable sector and inversely related to the initial degree of competition in this sector, as reflected in the term $-\frac{1}{\theta_N-1} \hat{\theta}_N$. The latter indicates that it is more effective to enhance competition in a sector where firms have a high degree of monopoly power. Second, the expansion of output in the non-tradables sector leads to higher labour demand. The bidding up of wages implies a higher costs of factor inputs for all sectors, which has an upward impact on the general price level, as shown by the term $\frac{\phi_N}{2(\theta_N-1)} \hat{\theta}_N$. Normally (when $\phi_N \approx 1 - \gamma$), this effect reduces the price impact of the first channel by roughly one half. Third, deregulating the non-tradables sector leads to an improvement in the Home country's terms of trade. The impact on the general price level of the terms of trade improvement is given by $-\gamma \overline{TOT}$. This channel is likely to be relatively small.\(^{45}\) Fourth, enhanced competition in the non-tradables sector generates a positive wealth effect for the Home country ($dF > 0$). The ensuing higher level

\(^{45}\)The terms of trade channel will become negligible if $\gamma \rightarrow 0$ or $\gamma \rightarrow 1$, as can be seen from the fully-reduced form. Intuitively, if the non-tradables sector is very small ($\gamma \rightarrow 1$), then enhanced competition in the non-tradables sector leads to a negligible change in import prices. Conversely, if the tradables sector is very small ($\gamma \rightarrow 0$), then enhanced competition in the non-tradables sector may induce a large
of consumption implies that money demand goes up. Therefore, keeping the nominal money supply unchanged, the general price level must go down to restore equilibrium in the money market. This fourth channel is also likely to be small when compared to the first two channels.\textsuperscript{46}

Three channels (lower monopoly rents, terms of trade improvement, higher money demand) go in the direction of a lower general price level, whereas one channel (higher wages) has an upward effect on the general price level. Thus, the overall price effect of increasing the degree of competition is a priori ambiguous, as was the case for the overall output effect. However, for all realistic parameter values ($\theta_T > \theta_N > 2$ or $\gamma < \frac{1}{2}$), enhanced competition has a downward effect on the relative price level in the Home country. Under the assumption that the initial level of competition in the tradables sector is more intense than in the non-tradables sector ($\theta_T > \theta_N$), one finds that the minimum decline in consumer prices in response to an increase in competition in the non-tradables sector is equal to half the direct impact of the reduced mark-up (the first channel):

$$\hat{\overline{P}}^d < -\frac{1 - \gamma}{2(\theta_N - 1)} \hat{\overline{\theta}}_N < 0. \quad (5.70)$$

At the world level, the terms of trade effects and wealth transfers cancel out. For realistic parameter values, enhanced competition increases world output:\textsuperscript{47}

$$\hat{\overline{Y}}^w = \hat{\overline{C}}^w = \left[\frac{1 - \gamma}{\theta_N - 1} - \frac{\phi_N}{2(\theta_N - 1)}\right] \hat{\overline{\theta}}_N. \quad (5.71)$$

Combining this result with the money demand equation (5.50) and its Foreign counterpart immediately shows that, under the same conditions, enhanced competition reduces the average world price level:

$$\hat{\overline{P}}^w = \left[\frac{\phi_N}{2(\theta_N - 1)}\right] - \frac{1 - \gamma}{\theta_N - 1} \hat{\overline{\theta}}_N. \quad (5.72)$$

The general price decline which follows from the enhancement of competition reflects a more efficient allocation of resources. Therefore, monetary policymakers should fully decline in import prices, but this will have a negligible impact on the overall price index. The channel also becomes negligible in case the tradable sector is fully competitive ($\theta_T \to \infty$).

\textsuperscript{46}The wealth effect/money demand channel will become negligible if $\gamma \to 0$ or $\gamma \to 1$, as can be seen from the fully-reduced form. Intuitively, if the non-tradables sector is very small ($\gamma \to 1$), then enhanced competition in the non-tradables sector leads to a negligible wealth transfer ($d\overline{F} \to 0$). Conversely, if the tradables sector is very small ($\gamma \to 0$), then enhanced competition in the non-tradables sector may lead to a wealth transfer which is large in terms of tradable goods, but this will have a negligible impact on overall consumption (and therefore also on money demand and the general price level).

\textsuperscript{47}Recall that $\gamma < \frac{1}{2}$ or $\theta_T > \theta_N$ is sufficient for $1 - \gamma > \phi_N$ (see Appendix 1).
accommodate this decline. Enhanced competition permanently lowers the price level, but it will only have a temporary effect on the level of inflation. Accommodating the price effect of enhanced competition therefore implies the need for a temporary adjustment of the policymaker’s inflation target. In order to derive the appropriate size of the adjustment, monetary policymakers need to distinguish the impact of enhanced competition from other sources of price changes. Equations (5.69) and (5.72) can play a useful role in this respect. Combined with an assessment of the length of the transitional period and the timing of the price effects, in principle, the appropriate temporary adjustment of the inflation target can be derived.

5.6.2 Short-run impact

Next, turn to the short run. The short-run world price level is:

$$\hat{P}_w^w = -\frac{1 - \gamma}{\theta_N - 1} \hat{\theta}_N^w.$$  \hspace{1cm} (5.73)

The expressions for world output, world consumption and the world interest rate are (see Appendix H):

$$\hat{Y}_w^w = \hat{C}_w^w = \frac{1 - \gamma}{\theta_N - 1} \hat{\theta}_N^w.$$  \hspace{1cm} (5.74)

$$\hat{r} = -(1 + \frac{1}{\hat{r}}) \frac{\phi_N}{2(\theta_N - 1)} \hat{\theta}_N^w.$$  \hspace{1cm} (5.75)

In the short run, wages only partially adjust to competition shocks. As a result, the short-run impact of competition policy on output exceeds its long-run impact [compare formulas (5.71) and (5.74)].

An increase in competition leads to a decline in the world real interest rate. The short-run impact of enhanced competition on world output exceeds the long-run impact. The

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48 In the case of product market deregulation, monetary policymakers will normally respond to second-round effects only (see ECB, 2001a). An example of second-round effects is that an initial reduction of inflation due to regulatory reforms may dampen the pressure on nominal wages (via lower inflation expectations). No such second-round effects occur in this model. This implies that monetary policymakers should fully accommodate the price declines which follow from enhanced competition in this paper.

49 It is important to note that this is not a conclusion of this paper. Rather, it follows by construction of the model: inflation is zero in the new steady state by assumption. There is some evidence that enhancing competition may have a permanent effect on inflation. See, for instance, Neiss (2001) and Caveaars (2003).

50 Nominal wages are fixed, but real wages are affected by the decline in the general price level.
real interest rate must decline in order to induce a similar time-pattern for consumption (via lower savings). Notice that the world nominal interest rate must decline even more strongly, given the situation of general price deflation.\(^{51}\)

Next, turn to short-run international differences:

\[
\tilde{C}^d = \left[ 1 - \frac{\gamma}{\theta_N - 1} - \frac{\gamma}{D} \frac{\theta_T - 1}{\theta_T} \frac{\phi_N}{\theta_N - 1} \right] \tilde{\theta}_N^d, \quad (5.76)
\]

\[
\tilde{Y}^d = \left[ 1 - \frac{\gamma}{\theta_N - 1} + \frac{\gamma}{D} \frac{\theta_T - 1}{\theta_T} \frac{\phi_N}{\theta_N - 1} \right] \tilde{\theta}_N^d, \quad (5.77)
\]

where \(D = 2 + \bar{r}(1 + \phi_N + \phi_T \theta_T)\). The short-run output difference (\(\tilde{Y}^d\)) and consumption difference (\(\tilde{C}^d\)) are always positive.\(^{52}\) The fact that monopolistic prices are set above marginal costs makes it profitable, at the margin, for firms to accommodate additional demand by producing more output. As will be seen below, an increase in competition in the Home non-tradables sector causes a depreciation of the Home currency (\(X > 0\)), which induces net Foreign demand for Home goods (\(\tilde{Y}^d > \tilde{C}^d\)).

The short-run change in the general price level is

\[
\tilde{P}^d = \left[ -\frac{1 - \gamma}{\theta_N - 1} + \frac{\gamma}{D} \frac{\theta_T - 1}{\theta_T} \frac{\phi_N}{\theta_N - 1} \right] \tilde{\theta}_N.
\]

Enhanced competition leads to a decline in the general price level, even in the short run.\(^{53}\) The reason is that the downward price impact of the decline in the profit margin in the non-tradables sector dominates the upward price effect of the wage increase. Thus, increasing the degree of competition in the non-tradables sector has beneficial short-run effects (lower prices, higher consumption).

### 5.6.3 Exchange rate and current account

The reduced-form solution of the short-run current account is:

\[
\frac{d\tilde{F}}{(C_T)^0} = \frac{\theta_T - 1}{D} \frac{\phi_N}{2(\theta_N - 1)} \tilde{\theta}_N^d. \quad (5.79)
\]

Enhanced competition in the Home non-tradables sector leads to a short-run surplus on the current account. Intuitively, enhanced competition in the non-tradable goods sector

\(^{51}\)If the nominal interest rate were constant, the decline of the general price level [equation (5.73)] would imply an increase of the real interest rate. In fact, a decline in the real interest rate can only be consistent with price deflation if the nominal interest rate declines even more.

\(^{52}\)It is straightforward to show that \(0 < \frac{1}{2(\theta_N - 1)} \tilde{\theta}_N^d < \tilde{C}^d < \frac{1}{\theta_N - 1} \tilde{\theta}_N^d < \tilde{Y}^d < (1 + \frac{\theta_T}{2}) \frac{1}{\theta_N - 1} \tilde{\theta}_N^d\). See appendix H.

\(^{53}\tilde{P}^d < 0\) immediately follows from \(\tilde{C}^d > 0\), as can be seen by comparing equations (5.76) and (5.78).
leads to a shift in Home demand away from tradable goods, which more than offsets the higher income which arises from higher employment and the higher real wage rate in the Home country. The lower Home demand for tradable goods implies that the short-run current account is in surplus. The short-run current account surplus is larger if the non-tradables sector is relatively uncompetitive to start with (i.e. if $\theta_N/\theta_T$ low). In this case, there will be a larger relative price decline of non-tradable goods, which enhances the demand shift from tradable to non-tradable goods in the Home country.

The short-run exchange rate immediately jumps to its long-run value. The exchange rate response is:

\[
\hat{X} = \frac{\theta_T - 1}{\theta_T} \left( \frac{\phi_N}{\theta_N - 1} \right) \frac{1}{D_T} \theta_N^d.
\]  

A permanent enhancement of non-tradables competition in the Home country ($\theta_N^d > 0$) leads to a depreciation of the Home currency ($\hat{X} > 0$). A depreciation is required, since the lower Home demand for tradable goods must be (partially) offset by higher Foreign demand for tradables.\(^{54}\)

The increase in producer prices in the Home country's tradable goods sector more than offsets the long-run depreciation of the Home currency. This implies that the Home country's long-run terms of trade improve as a result of enhanced competition in the non-tradables sector. The exact expression for the long-run terms of trade has been derived above, as it was needed to calculate the long-run international consumption differential. In the short run, output prices in the Home and Foreign tradables sector are not affected by a change in non-tradables competition, since nominal wages are fixed in the short run.\(^{55}\) Therefore, the change in the Home country short-run terms of trade is fully determined by the short-run change in the exchange rate. The depreciation of the Home currency means that the Home country experiences a short-run deterioration of its terms of trade.

\(^{54}\)There is an exchange rate magnification effect for competition shocks, in the sense that $\hat{X}$ is decreasing in $\gamma$. However, provided that $\theta_N > \frac{1}{2}$, we find that $\hat{X} < \theta_N^d$, so that the exchange-rate magnification effect is quantitatively unimportant for almost all admissible parameter values (see appendix J).

\(^{55}\)In the present model, increasing the degree of competition reduces the mark-up. Thus, output prices can change in the short run, i.e. nominal wage rigidity does not necessarily imply output price rigidity: more competition in the non-tradable goods sector leads to lower output prices in that sector. However, tradables prices are unaffected in the short run.
5.6.4 International spillovers

If the Home country is large, deregulation of its non-tradables sector will have an impact on Foreign as well. Foreign output equals:

\[ \hat{Y}^* = \frac{\gamma - \phi_T}{2} \frac{\bar{r}dF}{(C_T)'_0}. \]  

An increase in Home competition leads to a short-run current account surplus, so that Home accumulates net foreign assets \((dF > 0)\). The resulting wealth transfer from Foreign to Home induces Foreign workers to work more, leading to higher Foreign output. If the Home country is large, deregulation of its non-tradables sector will have an impact on Foreign as well. Foreign output equals:

\[ \hat{Y}^* = \frac{\gamma - \phi_T}{2} \frac{\bar{r}dF}{(C_T)'_0}. \]  

From equations (5.69) and (5.72), the Foreign price level:

\[ \hat{P}^* = \frac{1}{2} [\phi_T + \frac{\gamma(1 + \phi_N)}{\theta_T} \bar{r}dF] \frac{(C_T)'_0}{(C_T)'_0} + \frac{\gamma \phi_N}{4 \theta_T (\theta_N - 1)} \theta_N, \]

is affected via two channels. The first is a wealth transfer to the Home country. Lower wealth implies lower Foreign consumption; equilibrium in the Foreign money market then requires the Foreign general price level to go up. The second channel is that Foreign’s terms of trade worsen, so that the Foreign price level is pushed up by higher import prices. The long-run response of the Foreign CPI to enhanced competition in the Home country is unambiguously positive.

5.7 Conclusion

This chapter studies the macroeconomic impact of increasing competition in the non-tradables sector. Recent initiatives, both at the European level and in individual EU member states, promote a higher degree of competition in the goods and services markets. The degree in many non-tradables (services) markets is substantially less than in tradable

\[ \text{Foreign output can be derived from equations (5.67) and (5.71), as } \hat{Y}^* = \hat{Y}' - \frac{1}{2} \hat{y}'^d. \]

The condition \(\theta_N > 2(1 - \gamma)\) ensures that \(2 \gamma > \phi_T\). As argued earlier in this section, this condition will be satisfied in practice.

In more detail, the line of reasoning is as follows. Enhanced competition in Home leads to a short-run surplus on the Home current account, which leads to a wealth transfer from Foreign to Home. Lower Foreign wealth implies lower Foreign consumption, even when taking into account the shift of Foreign workers from leisure into work. Lower consumption implies lower money demand in Foreign. Given that the Foreign nominal money supply is fixed, the general price level must go up in order to restore equilibrium in the Foreign money market. The remainder of the increase in the general price level is due to the increase in the price of tradable goods. Enhanced competition in Home’s non-tradable goods sector leads to an improvement in Home’s terms of trade, which causes Foreign import prices to go up.
(goods) markets. Therefore, the non-tradables markets are priority fields of action for the competition authorities.

The chapter builds on the framework developed by Obstfeld and Rogoff. There are two countries in the model. Each country has two sectors (tradable and non-tradable goods). In contrast to Obstfeld and Rogoff (1995, 1996), the sectors may differ in the degree of competition. Moreover, I do not make the small-country assumption. These extensions to the existing literature have several interesting implications.

I confirm the existence of the 'exchange rate magnification effect' stressed by Hau (2000, 2002). Hau states that if the size of the tradable sector is small, changes in the fundamentals will induce relatively large exchange rate fluctuations. The intuition is that for a relatively closed economy, relatively large adjustments in the exchange rate are required in order to restore equilibrium in the domestic economy. I show that the effect is small though for all possible parameter values in the model.

Product market deregulation in the non-tradable goods sector leads to a lower mark-up and therefore to a decline in the price of non-tradables. However, more competition in the non-tradables sector may have negative spillovers to other sectors. More competition in the non-tradables sector triggers an increase in labour demand in the non-tradables sector, which causes a bidding up of real wages, leading to lower tradables output and a higher price for tradables in the new equilibrium. The implication is that deregulating the domestic services sector, via its impact on wages, will make a country less competitive internationally. This will induce a nominal depreciation of the Home currency.

Under realistic assumptions, an increase in the degree of competition in the non-tradables sector raises overall output and lowers the general price level in the domestic economy. This result is supportive of the Single Market project and of initiatives by EU national authorities to deregulate domestic services markets.

I have highlighted four channels through which competition policy may affect the general price level: (1) a decline in profit margins (directly), (2) an improvement in the terms of trade (via import prices), (3) an international wealth transfer (via its impact on money demand), and (4) an increase in labour demand (via wages). Whereas the first three channels contribute to lower prices, the fourth channel works in the other direction. Algebraically, the fourth channel reduces the direct price impact of lower profit margins (the first channel) by roughly one-half. The second and third channels are likely to be relatively small.

Finally, the model helps the ECB to distinguish the impact of enhanced competition (which should, in principle, not lead to a monetary policy response) from other factors which influence the general price level.
Appendices

A Consumption patterns

Consumers maximise one-period consumption $C = C_T^\gamma C_N^{1-\gamma}$, subject to budget constraint $P_T C_T + P_N C_N = PC$. The solution of this problem is equal to the solution of the dual problem

$$\text{Min}_{(C_T, C_N)} PC = P_T C_T + P_N C_N, \text{ subject to } C_T^\gamma C_N^{1-\gamma} = C,$$

with $C$ fixed. The first-order conditions are:

$$C_T = \frac{\lambda T}{P_T} C, \quad C_N = \frac{\lambda(1 - \gamma) T}{P_N} C.$$

Substituting the conditions back into the constraint yields

$$\lambda = \frac{P_T^\gamma P_N^{1-\gamma}}{\gamma(1 - \gamma)^{1-\gamma}}.$$

Substituting the last equation and the first-order conditions back into the goal function yields equations (5.5) and (5.13)-(5.14) in the main text. Combining the first-order conditions yields

$$\frac{C_T}{C_N} = \frac{\gamma T P_N}{1 - \gamma P_T},$$

or equivalently:

$$PC = \frac{P_T C_T}{\gamma} = \frac{P_N C_N}{1 - \gamma}.$$

B First-order conditions for households

The representative household maximises life-time utility (5.1), subject to the period budget constraint (5.10). The Lagrangian function is:

$$L_t = \sum_{s=t}^{\infty} \beta^{s-t} \left[ \gamma \log C_{T,s} + (1 - \gamma) \log C_{N,s} + \chi \log \left( \frac{M_s}{P_s} \right) - \frac{\kappa}{2} L_s^2 \right] + \nonumber$$

$$+ \lambda_s \left[ P_{T,s} F_s + M_s - P_{T,s} (1 + r_{s-1}) F_{s-1} - M_{s-1} - W_s L_s - \Pi_s + \right. \nonumber$$

$$\left. + P_{N,s} C_{N,s} + P_{T,s} C_{T,s} + P_{T,s} T_s \right].$$
The separability property of the utility function [see Obstfeld-Rogoff (1995)] implies that agents smooth consumption of tradable goods independently from consumption of non-tradable goods, which drastically simplifies the mathematics. The first-order conditions are

\[
\frac{\partial L_t}{\partial C_{T,s}} = \beta^{s-t} \frac{\gamma}{C_{T,s}} + \lambda_s P_{T,s} = 0, \\
\frac{\partial L_t}{\partial C_{N,s}} = \beta^{s-t} \frac{1 - \gamma}{C_{N,s}} + \lambda_s P_{N,s} = 0, \\
\frac{\partial L_t}{\partial M_s} = \beta^{s-t} \frac{\gamma}{M_s} + \lambda_s - \lambda_{s+1} = 0, \\
\frac{\partial L_t}{\partial L_s} = -\beta^{s-t} \kappa L_s - \lambda_s W_s = 0, \\
\frac{\partial L_t}{\partial F_s} = \lambda_s P_{T,s} - \lambda_{s+1} P_{T,s+1}(1 + r_s) = 0.
\]

Combining these conditions, eliminating \( \lambda \) and using equations (5.5), (5.12), (5.13)-(5.14) and (5.15)-(5.16), yields equations (5.18)-(5.19) in the main text.

C First-order conditions for firms

The representative firm sets the prices of its products so as to maximise profits

\[
Max_{\{p_N(z), p_T(z)\}} \Pi(z) = p_N(z)y_N(z) + p_T(z)y_T(z) - w(z)l(z).
\]

Substituting the goods markets clearing conditions (5.24)-(5.25) into the profit function yields

\[
\Pi(z) = p_N(z)c_N(z) + p_T(z)[\frac{1}{2}c_T(z) + \frac{1}{2}c_T^*(z)] - w(z)l(z).
\]

The first-order conditions are:

\[
\frac{d\Pi(z)}{dp_N(z)} = c_N(z) + p_N(z) \frac{\partial c_N(z)}{\partial p_N(z)} + p_T(z) \left[ \frac{1}{2} \frac{\partial c_T(z)}{\partial p_N(z)} + \frac{1}{2} \frac{\partial c_T^*(z)}{\partial p_N(z)} \right] - w(z) \frac{\partial l(z)}{\partial p_N(z)} = 0, \\
\frac{d\Pi(z)}{dp_T(z)} = \frac{1}{2} c_T(z) + \frac{1}{2} c_T^*(z) + p_N(z) \frac{\partial c_N(z)}{\partial p_T(z)} + p_T(z) \left[ \frac{1}{2} \frac{\partial c_T(z)}{\partial p_T(z)} + \frac{1}{2} \frac{\partial c_T^*(z)}{\partial p_T(z)} \right] + \\
- w(z) \frac{\partial l(z)}{\partial p_T(z)} = 0.
\]
It is assumed that the firm takes aggregate demand for tradable and non-tradable goods as given. This implies that it does not take into account any impact of its choice of \( p_N(z) [p_T(z)] \) on the demand for \( z_T(z_N) \), i.e. the cross-terms are zero:

\[
\frac{\partial c_T(z)}{\partial p_N(z)} = \frac{\partial c_T^*(z)}{\partial p_N(z)} = \frac{\partial c_N(z)}{\partial p_T(z)} = 0.
\]

Using the demand functions (5.15)-(5.16), the law of one price (5.8) and the production functions (5.22)-(5.23), the remaining (non-trivial) partial derivatives can be written as:

\[
\frac{\partial c_N(z)}{\partial p_N(z)} = -\theta_N \left( \frac{p_N(z)}{P_N} \right)^{-\theta_N^{-1}} \frac{C_N}{P_N} = -\theta_N \frac{c_N(z)}{p_N(z)},
\]

\[
\frac{\partial c_T(z)}{\partial p_T(z)} = -\theta_T \left( \frac{p_T(z)}{P_T} \right)^{-\theta_T^{-1}} \frac{C_T}{P_T} = -\theta_T \frac{c_T(z)}{p_T(z)},
\]

\[
\frac{\partial c_T^*(z)}{\partial p_T^*(z)} = -\theta_T \left( \frac{p_T^*(z)}{P_T^*} \right)^{-\theta_T^{-1}} \frac{C_T^*}{P_T^*} = -\theta_T \frac{c_T^*(z)}{p_T(z)},
\]

\[
\frac{\partial l(z)}{\partial p_N(z)} = \frac{1}{\alpha} \frac{\partial c_N(z)}{\partial p_N(z)} = -\frac{\theta_N c_N(z)}{\alpha p_N(z)},
\]

\[
\frac{\partial l(z)}{\partial p_T(z)} = \frac{1}{2\alpha} \frac{\partial c_T(z)}{\partial p_T(z)} = -\frac{\theta_T c_T(z)}{2\alpha p_T(z)}.
\]

Then the first-order conditions simplify to

\[
c_N(z) \left[ 1 - \theta_N + \frac{w(z)}{\alpha} \frac{\theta_N}{p_N(z)} \right] = 0,
\]

\[
\frac{1}{2} c_T(z) + \frac{1}{2} c_T^*(z) \left[ 1 - \theta_T + \frac{w(z)}{\alpha} \frac{\theta_T}{p_T(z)} \right] = 0.
\]

Assuming an interior solution, i.e. non-zero production levels, enables a further simplification to the first-order conditions (5.27)-(5.28) reported in the main text.

### D Steady-state consumption

Equation (5.34) can be derived as follows. In steady-state the individual household’s budget constraint (5.10) reduces to:

\[
\overline{P}_T F + \overline{M} = \overline{P}_T (1 + \overline{\tau}) F + \overline{M} + \overline{W} L + \overline{P}_N \overline{C}_N - \overline{P}_T \overline{C}_T - \overline{P}_T \overline{T},
\]
Chapter 5. Deregulation in the European Services Sector

Eliminate common terms, divide both sides by $\bar{P}_T$ and note that the government budget must be balanced in steady state. Then:

$$\frac{P_N \bar{C}_N + P_T \bar{C}_T}{P_T} - \frac{WL + \Pi}{P_T} = \bar{r}F,$$

i.e. domestic spending minus domestic income equals interest earned on net foreign assets. By definition

$$\bar{\Pi} = \int_0^{\frac{1}{2}} \Pi(z)dz = \int_0^{\frac{1}{2}} [p_N(z)y_N(z) + p_T(z)y_T(z) - w(z)l(z)]dz = \bar{P}_N^p Y_N + \bar{P}_T^p Y_T - WL,$$

where the final equality follows from symmetry among Home producers.

The price of non-tradable goods paid by Home consumers is equal to the price received by Home non-tradable producers, i.e. $P_N = P_N^p$. The price of tradable goods paid by Home consumers is a weighted average of the price received by Home tradable producers and the price of imported tradable goods (which is the exchange-rate adjusted price received by Foreign tradable producers).\(^{59}\) In the case of countries of equal size and symmetry among producers in each country (as assumed throughout this paper), the price index of tradables consumption is related to the producer price indices as $P_T = \frac{1}{2} P_T^p + \frac{1}{2} X (P_T^p)^*$.\(^{60}\)

Substituting the definition of profits into the equation above and taking into account the clearing condition for the domestic market for non-tradables (5.25) implies

$$\bar{C}_T = \bar{r}F + \frac{\bar{P}_N^p}{\bar{P}_T} Y_T.$$

The corresponding condition for Foreign is

$$\bar{C}_T^* = \bar{r}^*F^* + \frac{(P_T^p)^*}{P_T} Y_T^*.$$

Using world real interest equality (5.32) and the fact that world net foreign assets must be zero (i.e. $\bar{F} + F^* = 0$), the latter equation can be rewritten as

$$\bar{C}_T^* = -\bar{r}F + \frac{(P_T^p)^*}{P_T} Y_T^*.$$

\(^{59}\)Both assertions follow directly from the definition of the consumption-based price indices of non-tradable (tradable) goods and the assumed symmetry among Home (Foreign) producers.

\(^{60}\)Note that, in order to make clear that aggregate variables are meant, the production-based price indices of Home and Foreign tradable goods $[p_T(h)$ and $p_T^*(f)]$, are denoted as $P_T^p$ and $(P_T^p)^*$ respectively.
**E Current account dynamics**

The general expression for the current account is

\[
F_t - F_{t-1} = \frac{P^p Y_t}{P_t} - C_t + r_{t-1} F_{t-1},
\]

where the left hand side is a transfer of assets (the model does not distinguish between the capital account and the change in the official holdings of foreign assets) and the right hand side consists of the trade balance (the first two terms) and interest payments (the final term on the right hand side). The current account is defined as the sum of the trade balance and interest payments. Therefore, both the left hand side and the right hand side of this equation are equal to the current account balance. The current account equations in the initial steady state, in the short-run equilibrium and in the long-run equilibrium are all special cases of this general current account equation.

In the initial steady state, there is full international symmetry, which implies \( Y_0 = C_0 \) and \( (P^p)_0 = P_0 \). Moreover, it is assumed that initially neither country owns any net foreign assets, i.e. \( F_{-1} = 0 \). This implies that also \( F_0 = 0 \). Therefore, both the current account and the trade account must be in equilibrium in the initial steady state.

In the short-run equilibrium, the only constraint is that the initial net foreign assets are zero \( (F_{-1} = 0) \). Since there is no interest income, the current account balance must be equal to the trade balance. Since there is no requirement of international symmetry, the trade balance (and hence the current account) may show a surplus or a deficit. The short run current account equation thus simplifies to

\[
dF = \frac{P^p Y_t}{P_t} - C_t.
\]

The linearised short-run current account equation for the Home country is

\[
\frac{dF}{\bar{C}_0} = \hat{P}^p - \hat{P} + \hat{Y} - \hat{C}.
\]

In the long-run (steady state) equilibrium, the current account balance must be zero. [This no Ponzi game condition follows from combining the households’ and government’s budget constraints.] Therefore, net foreign assets remain at the level acquired during the short run \((dF)\) and the balance on the trade account must exactly offset the interest receipts (payments) on these net foreign assets (liabilities). The long-run current account equation is

\[
-\bar{r}dF = \frac{P^p Y}{\bar{P}} - \bar{C}.
\]
The linearised long-run current account equation for the Home country is
\[
-\gamma \frac{dF}{C_0} = \tilde{P}^p - \tilde{P} + \tilde{V} - \tilde{C}.
\]

**F Determinacy of the initial steady state**

The following eighteen equations hold at the level of individual countries: (5.5), (5.6), (5.7), (5.12), (5.13)-(5.14), (5.15)-(5.16), (5.18), (5.20), (5.21), (5.26), (5.27)-(5.28), (5.29), (5.31), (5.33)-(5.34). In the steady state, using the assumption of symmetry among producers in each country, these equations are:

\[
\bar{P} = \left(\frac{P_T}{\gamma}\right)^{\gamma} \left(\frac{P_N}{1-\gamma}\right)^{1-\gamma},
\]

\[
\bar{P}_T = \left[\frac{1}{2} \left[P_T^\theta \right]^{1-\theta_T} + \frac{1}{2} \left[\bar{X}(P_T^\theta)^{1-\theta_T}\right]^{1-\theta_T}\right], \quad \bar{P}_N = \bar{P}_N^p,
\]

\[
\bar{C}_T = \left(\frac{\gamma}{1-\gamma} \frac{P_N}{P_T}\right)^{1-\gamma} \bar{C}, \quad \bar{C}_N = \left(\frac{1-\gamma}{\gamma} \frac{P_T}{P_N}\right)^{1-\gamma} \bar{C},
\]

\[
\bar{V}_T = \left(\frac{\bar{P}_T}{\bar{P}_T}\right)^{\bar{\theta}_T} \bar{C}_T^w, \quad \bar{V}_N = \left(\frac{\bar{P}_N}{\bar{P}_N}\right)^{-\bar{\theta}_N} \bar{C}_N,
\]

\[
\bar{\gamma} = \frac{1-\beta}{\beta},
\]

\[
\bar{M} = \chi \bar{C} \left(\frac{1+\bar{i}}{\bar{i}}\right),
\]

\[
\bar{L} = \frac{1}{\kappa} \bar{P} \bar{C},
\]

\[
\bar{W} = \bar{P}_T^T \bar{V}_T + \bar{P}_N^T \bar{V}_N - WL,
\]

\[
\bar{P}_T^p = \left(\frac{\theta_T}{\theta_T - 1}\right) \bar{W}, \quad \bar{P}_N^p = \left(\frac{\theta_N}{\theta_N - 1}\right) \bar{W},
\]

\[
\bar{L} = \frac{1}{\alpha} (\bar{V}_T + \bar{V}_N),
\]

\[
\bar{V} = \bar{V}_T \bar{V}_N^{1-\gamma},
\]

\[
\bar{C}_N = \bar{V}_N, \quad \bar{C}_T = \bar{\gamma} \bar{F} + \frac{\bar{P}_T}{\bar{P}_T} \bar{V}_T.
\]
Three more equations hold at the world level:

\[
\begin{align*}
\bar{P}_T &= \bar{X}P^*_T, \\
\bar{C}_T^W &= \frac{1}{2}\bar{C}_T + \frac{1}{2}\bar{C}^*_T, \\
\bar{F} + \bar{F}^* &= 0.
\end{align*}
\]

Therefore, we have a total of \((2 \times 18 + 3) = 39\) equations. Four of these equations turn out to be redundant: (1) \(\bar{P}_T = \bar{X}P^*_T\) is implied by the definitions of the tradable goods price indices for the Home and Foreign country; (2) \(\bar{C}_N = \bar{Y}_N\) is implied by \(\bar{Y}_N = \left(\frac{\bar{P}_N}{\bar{P}_T}\right)^{-\theta_N} \bar{C}_N\) and \(\bar{P}_N = \bar{P}_T\); (3) the same is true for its Foreign counterpart \(\bar{C}^*_N = \bar{Y}^*_N\); (4) combination of \(\bar{C}_T^W = \frac{1}{2}\bar{C}_T + \frac{1}{2}\bar{C}^*_T\) with \(\bar{C}_T = \bar{r}\bar{F} + \frac{\bar{P}_T}{\bar{P}_N} \bar{Y}_T\) and \(\bar{Y}_T = \left(\frac{\bar{P}_T}{\bar{P}_N}\right)^{-\theta_T} \bar{C}_T^W\) and their Foreign counterparts yields \(\bar{P}_T = \left[\frac{1}{2} (\bar{P}_T^N)^{1-\theta_T} + \frac{1}{2} [\bar{X} (\bar{P}_T^N)^*]^{1-\theta_T}\right]^{1/(1-\theta_T)}\). Therefore, the above system consists of 35 independent equations.

The above system of equations contains 36 endogenous variables: seventeen for the Home country: \(\bar{Y}, \bar{Y}_T, \bar{Y}_N, \bar{C}, \bar{C}_T, \bar{C}_N, \bar{P}, \bar{P}_T, \bar{P}_N, \bar{P}_T^N, \bar{P}_N^N, \bar{W}, \bar{L}, \bar{\Pi}, \bar{F}, \bar{r}, \bar{i}\), seventeen for the Foreign country: \(\bar{Y}^*, \bar{Y}_T^*, \bar{Y}_N^*, \bar{C}^*, \bar{C}_T^*, \bar{C}_N^*, \bar{P}^*, \bar{P}_T^*, \bar{P}_N^*, (\bar{P}_T^N)^*, (\bar{P}_N^N)^*, \bar{W}^*, \bar{L}^*, \bar{\Pi}^*, \bar{F}^*, \bar{r}^*, \bar{i}^*\) and two variables that relate to both countries: \(\bar{C}_T^W\) and \(\bar{X}\).

As in Obstfeld and Rogoff (1995), the model is closed by imposing the starting condition of zero net foreign assets \((\bar{F}_0 = 0)\).

### G The loglinearised model

In this Appendix, I derive the loglinearised model and check whether the solution of the model is exactly determined.

#### G.1 Derivation of the loglinearised model

The purchasing power parity condition (5.9) is the easiest to linearise. Taking logs, taking total differentials and evaluating at the initial steady state yields

\[
\hat{P}_T = \hat{X} + \hat{P}^*_T.
\]

The consumer price index for non-tradable goods is equal to the average of domestic producer prices for non-tradable goods. The consumer price index for tradable goods is affected not only by domestic producer prices, but also by the price of imported tradable
goods. Given the symmetry among each country's producers and making use of (5.8), the expressions (5.6) and (5.7) can be rewritten as:

\[
P_N = p_N(h),
\]
\[
P_T = \left[ \int_0^1 p_T(z)^{1-\theta_T} \, dz + \int_0^1 X p_T^*(z)^{1-\theta_T} \, dz \right] \cdot \frac{1}{1-\theta_T} = \frac{1}{2} p_T(h)^{1-\theta_T} + \frac{1}{2} [X p_T^*(f)]^{1-\theta_T}.
\]

Linearisation of these equations yields the expressions for small percentage deviations of consumer prices from the initial steady state:

\[
\hat{P}_N = \hat{p}_N(h),
\]
\[
\hat{P}_T = \frac{1}{2} \hat{p}_T(h) + \frac{1}{2} [\hat{p}_T^*(f) + \hat{X}].
\]

The corresponding equations for the Foreign country are

\[
\hat{P}_N^* = \hat{p}_N^*(f),
\]
\[
\hat{P}_T^* = \frac{1}{2} [\hat{p}_T(h) - \hat{X}] + \frac{1}{2} \hat{p}_T^*(f).
\]

Linearising equations (5.27)-(5.28) yields the expressions for deviations of producer prices from the initial steady state

\[
\hat{p}_N(h) = -\frac{1}{\theta_N - 1} \hat{\theta}_N + \hat{W},
\]
\[
\hat{p}_T(h) = -\frac{1}{\theta_T - 1} \hat{\theta}_T + \hat{W}.
\]

Combining the last six equations yields equations (5.45)-(5.48) in the main text.

The log-linearised version of the expression for the general price index (5.5) is

\[
\hat{P} = \gamma \hat{P}_T + (1 - \gamma) \hat{P}_N.
\]

Percentage deviations from tradables (non-tradables) per capita consumption follow directly from log-linearising (5.13) and (5.14):

\[
\hat{C}_T = (1 - \gamma)(\hat{P}_N - \hat{P}_T) + \hat{C},
\]
\[
\hat{C}_N = \gamma(\hat{P}_T - \hat{P}_N) + \hat{C}.
\]

Linearising the expression for demand for individual tradable goods (5.17), substituting the market clearing condition (5.24) and aggregating over all tradable goods yields

\[
\hat{Y}_T = -\theta_T [\hat{P}_T^p - \hat{P}_T] + \hat{C}_T^W.
\]
A similar expression can be obtained for non-tradable goods, but this expression does not differ from the market clearing condition, due to the fact that the production-based and consumption-based price indices for non-tradable goods are identical.

Linearising the expression for world per capita tradables consumption (5.17) yields

\[ \hat{C}_T^w = \frac{1}{2} \hat{C}_T + \frac{1}{2} \hat{C}_T^* . \]

The linearised form of the first-order conditions of the households' intertemporal optimisation problem [(5.18), (5.20), (5.21)] is\(^{61}\)

\[
\begin{align*}
\hat{C}_{T,t+1} & = (1 - \beta)\hat{r}_t + \hat{C}_{T,t}, \\
\hat{M}_t - \hat{P}_t & = \hat{C}_t - \beta[\hat{r}_t + \frac{\hat{P}_{T,t+1} - \hat{P}_{T,t}}{1 - \beta}], \\
\hat{L} & = \hat{W} - \hat{P} - \hat{C}.
\end{align*}
\]

Linearising the definition of aggregate output (5.31) gives

\[ \hat{Y} = \gamma \hat{Y}_T + (1 - \gamma) \hat{Y}_N. \]

G.2 Determinacy of the loglinearised model

I will first consider the long-run. Thereafter, I will consider the equations for the short-run and the equations which relate both periods to each other.

In the long-run, the level of the net foreign assets \( \bar{F} \) is predetermined. There are fourteen equations for Home and fourteen corresponding equations for Foreign. Denoting long-run steady state changes by hatted overbars, the equations for Home are:

\[
\begin{align*}
\hat{P}_N^p & = -\frac{1}{\theta_N - 1} \hat{\theta}_N + \hat{W}, & \hat{P}_T^p & = -\frac{1}{\theta_T - 1} \hat{\theta}_T + \hat{W}, \\
\hat{P}_N & = -\frac{1}{\theta_N - 1} \hat{\theta}_N + \hat{W}, & \hat{P}_T & = -\frac{1}{\theta_T - 1} \hat{\theta}_T + \frac{1}{2}(\hat{W} + \hat{W}^*) + \frac{1}{2} \hat{X}, \\
\hat{P} & = \gamma \hat{P}_T + (1 - \gamma) \hat{P}_N,
\end{align*}
\]

\(^{61}\)Recall that equation (5.19) was superfluous. This equation is therefore left out here.
\[ \hat{C}_T = (1 - \gamma)(\hat{P}_N - \hat{P}_T) + \hat{C}, \quad \hat{C}_N = \gamma(\hat{P}_T - \hat{P}_N) + \hat{C}, \]

\[ \hat{Y}_T = -\theta_T[\hat{P}_T(h) - \hat{P}_T] + \hat{C}_T^W, \quad \hat{C}_N = \hat{Y}_N, \]

\[ \hat{L} = \hat{W} - \hat{P} - \hat{C}, \quad \hat{L}^* = \phi_T \hat{Y}_T + \phi_N \hat{Y}_N, \]

\[ \hat{Y} = \gamma \hat{Y}_T + (1 - \gamma) \hat{Y}_N, \]

\[ \hat{M} - \hat{P} = \hat{C}, \quad \hat{C}_T = \frac{1}{\tau} \frac{d\bar{F}}{(\hat{C}_T^W)_0} + \frac{1}{2} \left[ \hat{P}_T - (\hat{P}_T)^* - \hat{X} \right] + \hat{Y}_T, \quad \hat{C}_N = \hat{Y}_N. \]

Two equations relate to both countries:

\[ \hat{P}_T = \hat{X} + \hat{P}_T^*, \]
\[ \hat{C}_T = \frac{1}{2} \hat{C}_T + \frac{1}{2} \hat{C}_T^*. \]

The above system consists of 30 equations. However, the two equations which relate to both countries also follow directly from combining other equations in the system. Thus, there are 28 independent equations.

In the long run, there are 28 endogenous variables: thirteen for the Home country: \( \hat{Y}, \hat{Y}_T, \hat{Y}_N, \hat{C}, \hat{C}_T, \hat{C}_N, \hat{P}, \hat{P}_T, \hat{P}_T^p, \hat{P}_N, \hat{W}, \hat{L} \), thirteen for the Foreign country: \( \hat{Y}^*, \hat{Y}_T^*, \hat{Y}_N^*, \hat{C}^*, \hat{C}_T^*, \hat{C}_N^*, \hat{P}^*, \hat{P}_T^*, \hat{P}_N^*, (\hat{P}_T^*)^*, (\hat{P}_N^*)^*, \hat{W}^*, \hat{L}^* \) and two that relate to both countries: \( \hat{C}_T^W \) and \( \hat{X} \). Thus, the subsystem of long-run equations is exactly determined.

Next, turn to the short run. The nominal wage rate is fixed. There are twelve equations for Home and twelve corresponding equations for Foreign. Denoting short-run changes by hatted variables (no overbars), the short-run equations for Home are

\[ \hat{P}_N^p = -\frac{1}{\theta_N - 1} \hat{\theta}_N, \quad \hat{P}_T^p = -\frac{1}{\theta_T - 1} \hat{\theta}_T, \]
\[ \hat{P}_N = -\frac{1}{\theta_N - 1} \hat{\theta}_N, \quad \hat{P}_T = -\frac{1}{\theta_T - 1} \hat{\theta}_T + \frac{1}{2} \hat{X}, \]
\[ \hat{C}_T = (1 - \gamma)(\hat{P}_N - \hat{P}_T) + \hat{C}, \quad \hat{C}_N = \gamma(\hat{P}_T - \hat{P}_N) + \hat{C}, \]
\[ \hat{Y}_T = -\theta_T[\hat{P}_T(h) - \hat{P}_T] + \hat{C}_T^W, \quad \hat{C}_N = \hat{Y}_N, \]
\[ \hat{L} = \phi_T \hat{Y}_T + \phi_N \hat{Y}_N, \quad \hat{L}^* = -\hat{P} - \hat{C}, \]
\[ \hat{Y} = \gamma \hat{Y}_T + (1 - \gamma) \hat{Y}_N. \]
Three equations for each country relate the short run to the long run:

\[ \hat{C}_T - \hat{C}_T = (1 - \beta)\hat{r}, \]
\[ \hat{M} - \hat{p} = \hat{c} - \beta\hat{r} - \frac{\beta}{1 - \beta}(\hat{p}_T - \hat{p}_T), \]
\[ \frac{d\hat{F}}{(C^W_T)_t} = \hat{V}_T - \hat{C}_T + \frac{1}{2}[\hat{p}_T(h) - \hat{p}_T(f) - \hat{x}]. \]

Two equations relate to both countries:

\[ \hat{p}_T = \hat{x} + \hat{p}^*_T, \]
\[ \hat{c}^W_T = \frac{1}{2}\hat{c}_T + \frac{1}{2}\hat{c}^*_T. \]

The above system consists of 32 equations. The two equations which relate to both countries also follow from combining other equations in the system. Thus, there are 30 independent equations. There are 30 endogenous variables: thirteen for Home: \( \hat{Y}, \hat{V}_T, \hat{Y}_N, \hat{C}, \hat{C}_T, \hat{C}_N, \hat{P}, \hat{P}_T, \hat{P}_N, \hat{P}_p, \hat{P}_p', \hat{L}, \hat{L}^*, \) thirteen for Foreign: \( \hat{Y}^*, \hat{V}_T^*, \hat{Y}^*_N, \hat{C}^*, \hat{C}_T^*, \hat{C}_N^*, \hat{P}^*, \hat{P}_T^*, \hat{P}_N^*, (\hat{P}_p^*)', (\hat{P}_p^*)^*, \hat{L}^*, (\hat{L}^*)^* \) and four variables that relate to both countries: \( \hat{C}^W_T, \hat{x}, \hat{r}, \) and \( d\hat{F}. \)

Thus, the subsystem of short-run equations is exactly determined.

**H Solution of the loglinearised model**

**H.1 The model in country differences and world aggregates**

It is straightforward to rewrite the equations of the loglinearised model in terms of differences between Home and Foreign variables and in terms of world aggregates. Define: \( x^d = x - x^* \) and \( x^w = \frac{1}{2}(x + x^*) \), for any variable \( x \).

The long-run equations can be rewritten as thirteen independent equations in world

---

\[ ^{62}\text{Note that additional variables } \hat{L}^* \text{ and } (\hat{L}^*)^* \text{ have been introduced, which denote labour supply in the Home and Foreign country, respectively. The reason for doing this is that the labour-leisure equations do not bind in the short run. In other words, the labour markets do not necessarily clear in the short run.} \]
aggregates:

\[
(P_N)^w = -\frac{1}{\theta_N - 1} \theta_N^w + \hat{W}^w, \quad \hat{P}^w = \hat{W}^w,
\]

\[
\hat{P}_N^w = -\frac{1}{\theta_N - 1} \theta_N^w + \hat{W}, \quad \hat{P}_T^w = \hat{W}^w,
\]

\[
\hat{P}^w = \gamma \hat{P}_T^w + (1 - \gamma) \hat{P}_N^w,
\]

\[
\hat{C}_T^w = (1 - \gamma)(\hat{P}_N^w - \hat{P}_T^w) + \hat{C}, \quad \hat{C}_N^w = \gamma(\hat{P}_T^w - \hat{P}_N^w) + \hat{C}_N^w,
\]

\[
\hat{Y}_T^w = \hat{C}_N^w, \quad \hat{C}_N^w = \hat{Y}_N^w.
\]

\[
\hat{L} = \hat{W}^w - \hat{P}_T^w - \hat{C}, \quad \hat{L} = \hat{P}_T^w - \hat{P}_N^w - \hat{C}_N^w,
\]

\[
\hat{Y}^w = \gamma \hat{Y}_T^w + (1 - \gamma) \hat{Y}_N^w,
\]

and fourteen independent equations in country differences:

\[
\hat{P}_N^d = -\frac{1}{\theta_N - 1} \theta_N^d + \hat{W}^d, \quad \hat{P}_T^d = \hat{W}^d,
\]

\[
\hat{P}_N^d = -\frac{1}{\theta_N - 1} \theta_N^d + \hat{W}^d, \quad \hat{P}_T^d = \hat{W}^d,
\]

\[
\hat{P}^d = \gamma \hat{P}_T^d + (1 - \gamma) \hat{P}_N^d,
\]

\[
\hat{C}_T^d = (1 - \gamma)(\hat{P}_N^d - \hat{P}_T^d) + \hat{C}_d, \quad \hat{C}_N^d = \gamma(\hat{P}_T^d - \hat{P}_N^d) + \hat{C}_N^d,
\]

\[
\hat{Y}_T^d = -\theta_T(\hat{P}_N^d - \hat{P}_T^d), \quad \hat{Y}_T^d = \theta_T(\hat{P}_N^d - \hat{P}_T^d),
\]

\[
\hat{L} = \hat{W} - \hat{P}_T - \hat{C}, \quad \hat{L} = \hat{W} - \hat{P}_N - \hat{C}_N,
\]

\[
\hat{Y}^d = \gamma \hat{Y}_T^d + (1 - \gamma) \hat{Y}_N^d,
\]

\[
\hat{M} - \hat{P}_T = \hat{C}_d,
\]

\[
\hat{C}_T^d = 2\hat{F} \frac{d\hat{F}}{(\hat{C}_T^w)_0} + (\hat{P}_T^d)^2 - \hat{P}_T^d + \hat{Y}_T, \quad \hat{C}_N^d = \hat{Y}_N^d.
\]

Note that \(d\hat{F}\) is predetermined (in the short run, as will be seen below). Thus, there are 27 independent equations in 27 endogenous variables: \(\hat{Y}_T^w, \hat{Y}_T^d, \hat{Y}_N^w, \hat{Y}_N^d, \hat{C}_T^w, \hat{C}_T^d, \hat{C}_N^w, \hat{C}_N^d, \hat{P}_T^w, \hat{P}_T^d, \hat{P}_N^w, \hat{P}_N^d, \hat{W}, \hat{L}, \hat{Y}_T^w, \hat{Y}_T^d, \hat{Y}_N^w, \hat{Y}_N^d, \hat{C}_T^w, \hat{C}_T^d, \hat{C}_N^w, \hat{C}_N^d, \hat{P}_T^w, \hat{P}_T^d, (\hat{P}_T^w)^2, (\hat{P}_N^w)^2, \hat{P}_N^w, \hat{W}, \hat{L}, \hat{X}.


Next, turn to the short run and recall that nominal wages are fixed in the short run. The short-run equations (and the equations relating the short and long run) can be rewritten as fourteen independent equations in world aggregates:

\[
\begin{align*}
(P_N^p)^w &= -\frac{1}{\theta_N - 1} \hat{\theta}_N^w, & (P_T^p)^w &= 0, \\
\hat{P}_N^w &= -\frac{1}{\theta_N - 1} \hat{\theta}_N^w, & \hat{P}_T^w &= 0, \\
\hat{P}_N^w &= \gamma \hat{P}_T^w + (1 - \gamma) \hat{P}_N^w, \\
\hat{C}_N^w &= (1 - \gamma)(\hat{P}_N^w - \hat{P}_T^w) + \hat{C}_w, \\
\hat{Y}_T^w &= \hat{C}_T^w, \\
\hat{L}_w &= \phi_T \hat{Y}_T^w + \phi_N \hat{Y}_N^w, \\
(\hat{L}_T^w) &= -\hat{P}_w - \hat{C}_w, \\
\hat{Y}_w &= \gamma \hat{Y}_T^w + (1 - \gamma) \hat{Y}_N^w, \\
\hat{C}_T^w - \hat{C}_w &= (1 - \beta) \hat{Y}, \\
\hat{P}_w - \hat{P}_w &= \hat{C}_w - \beta \hat{Y} - \frac{\beta}{1 - \beta}(\hat{P}_T^w - \hat{P}_T^w),
\end{align*}
\]

and fifteen independent equations in terms of country differences:

\[
\begin{align*}
(P_N^p)^d &= -\frac{1}{\theta_N - 1} \hat{\theta}_N^d, & (P_T^p)^d &= 0, \\
\hat{P}_N^d &= -\frac{1}{\theta_N - 1} \hat{\theta}_N^d, & \hat{P}_T^d &= \hat{X}, \\
\hat{P}_d &= \gamma \hat{P}_T^d + (1 - \gamma) \hat{P}_N^d, \\
\hat{C}_N^d &= (1 - \gamma)(\hat{P}_N^d - \hat{P}_T^d) + \hat{C}_d, \\
\hat{Y}_T^d &= -\theta_T (\hat{P}_T^p)^d + \theta_T \hat{P}_T^d, \\
\hat{Y}_d &= \phi_T \hat{Y}_T^d + \phi_N \hat{Y}_N^d, \\
(\hat{L}_T^d) &= -\hat{P}_d - \hat{C}_d, \\
\hat{Y}_d &= \gamma \hat{Y}_T^d + (1 - \gamma) \hat{Y}_N^d, \\
\hat{C}_T^d - \hat{C}_d &= 0, \\
\hat{M}_d - \hat{P}_d &= \hat{C}_d - \frac{\beta}{1 - \beta}(\hat{P}_T^d - \hat{P}_T^d), \\
2 \frac{d\hat{F}}{(C_T^w)_0} &= (\hat{P}_T^p)^d - \hat{P}_T^d + \hat{Y}_T^d - \hat{C}_T^d.
\end{align*}
\]

Note that \( \hat{P}_d \) and \( \hat{C}_T^d \) are determined in the long run (see above). Thus, there are 29 independent equations in 29 endogenous variables: \( \hat{Y}_w, \hat{Y}_T^w, \hat{Y}_N^w, \hat{C}_w, \hat{C}_T^w, \hat{C}_N^w, \hat{P}_w, \hat{P}_T^w \).
H.2 Semi-reduced form solution

Solve the model for a permanent money shock and a permanent shock to the degree of competition in non-tradables. Since shocks are additive, the model can be solved for both shocks simultaneously. Assume that the degree of competition in tradables does not change. The solution of the model is given below. The results are discussed in the main text.

I first solve the long-run part of the model. This yields the following long-run solution for world aggregates:

\[
\begin{align*}
\hat{Y}^w_N &= \hat{C}_N^w = \frac{1 + \phi_T}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{Y}^w_T &= \hat{C}_T^w = -\frac{1 - \phi_T}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{P}_N^w &= \hat{M}^w - \frac{1 + \phi_T}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{P}_T^w &= \hat{M}^w + \frac{1 - \phi_T}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{L}^w &= \frac{1 - \phi_T}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{W}^w &= \hat{M}^w + \frac{1 - \phi_T}{2(\theta_N - 1)} \hat{\theta}_N.
\end{align*}
\]

The long-run solution for country differences is:

\[
\begin{align*}
\hat{Y}^d_N &= \hat{C}^d_N = \phi_T \frac{\bar{r}d\bar{F}}{(\hat{C}^w_T)_0} + \frac{1 + \phi_T}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{Y}^d_T &= -(1 + \phi_N) \frac{\bar{r}d\bar{F}}{(\hat{C}^w_T)_0} - \frac{\phi_N(\theta_T - 1)}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{C}^d_T &= \left[\phi_T + \frac{1 + \phi_N}{\theta_T} \right] \frac{\bar{r}d\bar{F}}{(\hat{C}^w_T)_0} - \frac{\phi_N(\theta_T - 1)}{2\theta_T(\theta_N - 1)} \hat{\theta}_N, \\
\hat{Y}^d &= -(2\gamma - \phi_T) \frac{\bar{r}d\bar{F}}{(\hat{C}^w_T)_0} + \frac{1 + \phi_T - 2\gamma}{2(\theta_N - 1)} \hat{\theta}_N, \\
\hat{C}^d &= \left[\phi_T + \frac{\gamma(1 + \phi_N)}{\theta_T} \right] \frac{\bar{r}d\bar{F}}{(\hat{C}^w_T)_0} + \frac{\theta_T(1 + \phi_T - 2\gamma) + \gamma\phi_N}{2\theta_T(\theta_N - 1)} \hat{\theta}_N.
\end{align*}
\]
The long-run solution for the exchange rate and the terms of trade is:

\[
\hat{X} = \frac{\zeta^d}{M} = \left[\phi_T + \frac{1 + \phi_N}{\theta_T}\right] \frac{\bar{r}d\bar{F}}{(C_{T})_0} + \frac{\phi_N(\theta_T - 1) \zeta^d}{2\theta_T(\theta_N - 1) \theta_N},
\]

\[
\hat{P}_T^d - (\hat{P}_T)^* - \hat{X} = \frac{1 + \phi_N}{\theta_T} \frac{\bar{r}d\bar{F}}{(C_{T})_0} + \frac{\phi_N}{2\theta_T(\theta_N - 1) \theta_N} \zeta^d.
\]

Next, solve the short-run part of the model. Recall that nominal wages are fixed in the short run. This yields the following short-run solution for world aggregates:

\[
\hat{Y}_N^w = \hat{C}_N^w = (1 - \beta)\hat{M}_w + \beta\hat{P}_T^w + \beta\hat{C}_T^w + \frac{1}{\theta_N - 1} \theta_N,
\]
\[
\hat{Y}_T^w = \hat{C}_T^w = (1 - \beta)\hat{M}_w + \beta\hat{P}_T^w + \beta\hat{C}_T^w,
\]
\[
\hat{Y}_w = \hat{C}_w^w = (1 - \beta)\hat{M}_w + \beta\hat{P}_T^w + \beta\hat{C}_T^w + \frac{1 - \gamma}{\theta_N - 1} \theta_N,
\]
\[
\hat{P}_N^w = \frac{1}{\theta_N - 1} \theta_N,
\]
\[
\hat{P}_T^w = \frac{1 - \gamma}{\theta_N - 1} \theta_N,
\]
\[
\hat{L}^w = (1 - \beta)\hat{M}_w + \beta\hat{P}_T + \beta\hat{C}_T + \frac{\phi_N}{\theta_N - 1} \theta_N.
\]
The short-run solution for country differences is:

\[
\begin{align*}
\hat{Y}_N^d &= \hat{C}_N^d = \hat{M}^d + \frac{1}{\theta_N - 1} \hat{\theta}_N^d, \\
\hat{Y}_T^d &= \theta_T \hat{M}^d - \theta_T \hat{C}_T^d.
\end{align*}
\]

\[
\begin{align*}
\hat{\hat{C}}_T^d &= \hat{\hat{C}}_T, \\
\hat{\hat{Y}}^d &= [1 + \gamma(\theta_T - 1)] \hat{\hat{M}}^d - \gamma \theta_T \hat{\hat{C}}_T + \frac{1 - \gamma}{\theta_N - 1} \hat{\hat{\theta}}_N^d, \\
\hat{\hat{C}}^d &= (1 - \gamma) \hat{\hat{M}}^d + \gamma \hat{\hat{C}}_T + \frac{1 - \gamma}{\theta_N - 1} \hat{\hat{\theta}}_N^d, \\
\hat{\hat{P}}_N^d &= -\frac{1}{\theta_N - 1} \hat{\hat{\theta}}_N^d, \\
\hat{\hat{P}}_T^d &= \hat{\hat{M}}^d - \hat{\hat{C}}_T^d, \\
\hat{\hat{P}}^d &= \gamma \hat{\hat{M}}^d - \gamma \hat{\hat{C}}_T + \frac{1 - \gamma}{\theta_N - 1} \hat{\hat{\theta}}_N^d, \\
\hat{\hat{L}}^d &= (\phi_N + \phi_T \theta_T) \hat{\hat{M}}^d - \phi_T \theta_T \hat{\hat{C}}_T + \frac{\phi_N}{\theta_N - 1} \hat{\hat{\theta}}_N^d.
\end{align*}
\]

The short-run change in the interest rate and the short-run current account balance are:

\[
\hat{\hat{r}} = -\hat{\hat{M}}^w - \frac{\beta}{1 - \beta} \hat{\hat{P}}^w_T + \hat{\hat{C}}_T, \\
\frac{d\hat{\hat{F}}}{(C^w_T)_0} = \frac{\theta_T - 1}{2} \hat{\hat{\theta}}_N^d - \frac{\theta_T \hat{\hat{\theta}}_N^d}{2 \hat{\hat{C}}_T}.
\]

The short-run change in the exchange rate is equal to the long-run change:

\[
\hat{\hat{X}} = \hat{\hat{X}}.
\]

The short-run terms of trade are equal to minus the exchange rate:

\[
\hat{\hat{P}}^p_T - (\hat{\hat{P}}^p_T)^* - \hat{\hat{X}} = \hat{\hat{W}}^d - \hat{\hat{X}} = -\hat{\hat{X}}.
\]

**H.3 Reduced-form solution for main variables**

The long-run and the short-run equations can be combined, in order to obtain the reduced-form solution of the model. Recall that I consider the special case of permanent shocks, i.e. \( \hat{\hat{M}} = \hat{\hat{M}}, \hat{\theta}_T = \hat{\theta}_T, \hat{\theta}_N = \hat{\theta}_N. \) The long-run variables that appear in the short-run solution (\( \hat{\hat{C}}_T \) and \( \hat{\hat{P}}_T \)) are combined with the short-run variable that appears in the long-run solution (\( d\hat{\hat{F}}/(C^w_T)_0 \)). Also, \( \beta \) has been eliminated from the equations by
recalling that $\tilde{r} = \frac{1-\beta}{\beta}$. This yields:

$$\frac{d\tilde{F}}{(C_T^w)_0} = \frac{\theta_T - 1}{D} [\tilde{M}^d + \frac{\phi_N}{2(\theta_N - 1)} \tilde{\theta}_N],$$

$$\tilde{C}_T^d = \left( \frac{\theta_T - 1}{\theta_T} \right) \frac{1}{D} [\tilde{r}(1 + \phi_N + \phi_T \theta_T) \tilde{M}^d + \frac{\phi_N}{\theta_N - 1} \tilde{\theta}_N],$$

$$\tilde{P}_T^d = [1 - \left( \frac{\theta_T - 1}{\theta_T} \right) \tilde{r}(1 + \phi_N + \phi_T \theta_T) \tilde{M}^d + \frac{\theta_T - 1}{\theta_T} \frac{\phi_N}{\theta_N - 1} \frac{1}{D} \tilde{\theta}_N],$$

$$\tilde{C}_T^w = -\frac{\phi_N}{2(\theta_N - 1)} \tilde{\theta}_N,$$

$$\tilde{P}_T^w = \tilde{M}^w + \frac{\phi_N}{2(\theta_N - 1)} \tilde{\theta}_N,$$

where

$$D = 2 + \tilde{r}(1 + \phi_N + \phi_T \theta_T).$$

Substituting the expressions for $\tilde{C}_T^w$ and $\tilde{P}_T^w$ into the earlier equation for $\tilde{r}$ yields a simplified expression for the short-run change in the world interest rate:

$$\tilde{r} = -(1 + \frac{1}{\tilde{r}}) [\tilde{M}^w + \frac{\phi_N}{2(\theta_N - 1)} \tilde{\theta}_N].$$

Substituting the results for $\frac{d\tilde{F}}{(C_T^w)_0}, \tilde{C}_T^w, \tilde{C}_T^d, \tilde{P}_T^w, \tilde{P}_T^d$ into the equations that were obtained earlier for output, consumption and the general price level yields reduced-form solutions for those variables. The long-run solution for world aggregates is:

$$\tilde{Y}^w = \tilde{C} = \frac{1 + \phi_T - 2\gamma \tilde{\gamma}_w}{2(\theta_N - 1)} \tilde{\theta}_N,$$

$$\tilde{P}^w = \tilde{M}^w - \frac{1 + \phi_T - 2\gamma \tilde{\gamma}_w}{2(\theta_N - 1)} \tilde{\theta}_N,$$

The long-run solution for country differences is:

$$\tilde{Y}^d = \frac{-(2\gamma - \phi_T)(\theta_T - 1)\tilde{r}}{D} \tilde{M}^d +$$

$$+ \frac{1}{2(\theta_N - 1)} \left[ 1 + \phi_T - 2\gamma - \frac{(2\gamma - \phi_T)\phi_N(\theta_T - 1)\tilde{r}}{D} \right] \tilde{\theta}_N.$$
where $D$ as defined above. Note that

$$
\frac{\gamma}{D} \left( \frac{\theta_T - 1}{\theta_T} \right) \frac{\phi_N}{\theta_N - 1} < \frac{\gamma}{2} \left( \frac{\theta_T - 1}{\theta_T} \right) \frac{\phi_N}{\theta_N - 1} = \frac{\gamma(\theta_T - 1)}{2\theta_T(\theta_N - 1)} \left( \frac{\theta_T}{\theta_T} - 1 \right) \left( \frac{\phi_N}{\theta_N - 1} \right) = \frac{(1 - \gamma)(\frac{\theta_T}{\theta_T} - 1)}{2\theta_N} \left( \frac{\theta_T}{\theta_T} - 1 \right) \frac{\phi_N}{\theta_N - 1} = \frac{(1 - \gamma)\phi_T}{2\theta_N} < \frac{1 - \gamma}{2(\theta_N - 1)} < \frac{1 - \gamma}{2(\theta_N - 1)}.
$$

Then it is easy to see that

$$
\frac{1 - \gamma}{2(\theta_N - 1)} < \frac{\gamma dC}{\theta_N} < \frac{1 - \gamma}{2(\theta_N - 1)} < \frac{\gamma dY}{\theta_N} < \frac{1 - \gamma}{2(\theta_N - 1)} > \frac{1 - \gamma}{2(\theta_N - 1)}.
$$

Then, the signs of the short-run response coefficients can be determined for all admissible values of the underlying parameters:

$$
\frac{d\hat{Y}^w}{dM^u} > 0, \quad \frac{d\hat{C}^w}{dM^u} > 0, \quad \frac{d\hat{P}^w}{dM^u} = 0, \quad \frac{d\hat{Y}^d}{dM^d} > 0, \quad \frac{d\hat{C}^d}{dM^d} > 0, \quad \frac{d\hat{P}^d}{dM^d} < 0, \quad \frac{d\hat{P}^d}{dM^d} < 0, \quad \frac{d\hat{P}^d}{dM^d} < 0.
$$

The short-run solution for the exchange rate and the terms of trade are:

$$
\hat{X} = \frac{2\theta_T + \gamma(1 + \phi_N + \phi_T\theta_T)}{\theta_T D} \hat{M}^d + \frac{\theta_T - 1}{\theta_T} \left( \frac{\phi_N}{\theta_N - 1} \right) \frac{1 - \gamma}{D},
$$

$$
\hat{P}_T^d - (\hat{P}_T^d)^* - \hat{X} = -\hat{X}.
$$

I Relationship between several model parameters

First, recall that $\phi_T$ and $\phi_N$ are given by

$$
\phi_T = \frac{\gamma(\frac{\theta_T - 1}{\theta_T})}{\gamma(\frac{\theta_T - 1}{\theta_T}) + (1 - \gamma)(\frac{\theta_N - 1}{\theta_N})}, \quad \phi_N = \frac{(1 - \gamma)(\frac{\theta_N - 1}{\theta_N})}{\gamma(\frac{\theta_T - 1}{\theta_T}) + (1 - \gamma)(\frac{\theta_N - 1}{\theta_N})},
$$

and note that $\phi_T + \phi_N = 1$. Then we can establish the following relationships, which help to determine the sign of response coefficients in the main text.

**Lemma 1:** If $\gamma < \frac{1}{2}$, then $1 + \phi_T - 2\gamma > 0$. 

Proof: If $\gamma < \frac{1}{2}$, then $1 - 2\gamma > 0$. Note that $\phi_T > 0$. It then follows immediately that $1 + \phi_T - 2\gamma > 0$.

Lemma 2: If $\theta_N > 2(1 - \gamma)$, then $\phi_T < 2\gamma$.

Proof: Note that

$$\phi_T = \frac{\gamma}{\gamma + (1 - \gamma)(\frac{\theta_N - 1}{\theta_N})(\frac{\theta_N - 1}{\theta_N - 1})}$$

is increasing in $\theta_N$. Therefore,

$$\phi_T < \lim_{\theta_N \to \infty} \phi_T = \frac{\gamma}{\gamma + (1 - \gamma)(\frac{\theta_N - 1}{\theta_N})}.$$ 

Since $\phi_T$ is decreasing in $\theta_N$, it follows immediately from $\theta_N > 2(1 - \gamma)$, that

$$\phi_T < \frac{\gamma}{\gamma + (1 - \gamma)(\frac{1 - 2\gamma}{2 - 2\gamma})} = \frac{1}{2},$$

where the final equality follows from the fact that

$$\gamma + (1 - \gamma)(\frac{1 - 2\gamma}{2 - 2\gamma}) = \gamma + \frac{1}{2}(1 - 2\gamma) = \frac{1}{2}. $$

Lemma 3: If $\theta_N > 1\frac{1}{2}$, then $\phi_T < \frac{1}{2}$.

Proof: This follows immediately from lemma 2, by setting $\gamma = \frac{1}{4}$.

Lemma 4: If $\theta_T > \theta_N$, then $\phi_T > \gamma$.

Proof: Recall that

$$\phi_T = \frac{\gamma(\frac{\theta_T - 1}{\theta_T})}{\gamma(\frac{\theta_T - 1}{\theta_T}) + (1 - \gamma)(\frac{\theta_N - 1}{\theta_N})}.$$ 

is increasing in $\theta_T$. Therefore, it follows immediately from $\theta_T > \theta_N$ that

$$\phi_T > \frac{\gamma(\frac{\theta_N - 1}{\theta_N})}{\gamma(\frac{\theta_N - 1}{\theta_N}) + (1 - \gamma)(\frac{\theta_N - 1}{\theta_N})} = \frac{\gamma}{\gamma + (1 - \gamma)} = \gamma,$$

or, equivalently, $\phi_N < 1 - \gamma$.

J The exchange rate

This appendix shows that the exchange rate magnification effect stressed by Hau (2000, 2002) is also present in my model, both for money shocks and for competition shocks, but that it is quantitatively unimportant for almost all admissible parameter values. It also shows that no exchange rate overshooting takes place in the model.
J.1 Size of the exchange rate magnification effect

From Appendix I.2:

\[ \hat{X} = \frac{2\theta_T + \bar{r}(1 + \phi_N + \phi_T\theta_T) - \hat{M}^d + \theta_T - 1}{\theta_T(\theta - 1)} \frac{1}{D}\theta_N^d, \]

where \( D = 2 + \bar{r}(1 + \phi_N + \phi_T\theta_T) \).

The absolute size of \( \hat{X} \) is decreasing in \( \gamma \). In other words, the exchange rate movement is larger for relatively closed economies. This can be seen as follows. The coefficient of \( \hat{M}^d \) is decreasing in the term \( 1 + \phi_N + \phi_T\theta_T \). This term is equivalent to \( 2 + \phi_T(\theta_T - 1) \), so that the coefficient of \( \hat{M}^d \) is decreasing in \( \phi_T \) and therefore decreasing in \( \gamma \). Similarly, the coefficient of \( \hat{\theta}_N^d \) is increasing in \( \phi_N/D \), which is equivalent to \( (1 - \phi_T)/D \), so that the coefficient of \( \hat{\theta}_N^d \) is decreasing in \( \phi_T \) and therefore decreasing in \( \gamma \).

It is also easy to show that both coefficients normally do not exceed one:

Lemma 1: The exchange rate magnification effect is unimportant for all admissible parameter values in the case of money shocks.

Proof: Note that all parameters \((\theta_T, \phi_T, \phi_N, \bar{r})\) are positive and that \( \theta_T > 1 \), so that the coefficient for \( \hat{M}^d \) is between 0 and 1 for all parameter values.

Lemma 2: The exchange rate magnification effect is unimportant in the case of competition shocks, unless the initial degree of competition in the non-tradable goods sector is extremely limited.

Proof: It is immediately clear that the coefficient for \( \hat{\theta}_N^d \) is positive for all parameter values. Note that \((\theta_T - 1)/\theta_T < 1, \phi_N < 1 \) and \( D > 2 \), so that a sufficient condition for the coefficient of \( \hat{\theta}_N^d \) to be smaller than one is \( 1/[2(\theta_N - 1)] < 1 \), or \( \theta_N > \frac{3}{2} \).

J.2 No exchange rate overshooting

Combining the linearised versions of (5.5), (5.9) and (5.13) with long run money market equilibrium yields:

\[ \hat{M}^d = \hat{C}^d + \hat{P}^d = \hat{C}_T + \hat{X}. \]

The linearised versions of (5.5), (5.9) and (5.13) also hold in the short run. Combining these equations with short run money market equilibrium yields:

\[ \tilde{M}^d = \tilde{C}^d + \tilde{P}^d - \frac{\beta}{1 - \beta}(\tilde{X} - \tilde{X}) = \]

\[ = \tilde{C}_T + \tilde{X} - \frac{\beta}{1 - \beta}(\tilde{X} - \tilde{X}). \]
Recall that we consider permanent money shocks (i.e. $\hat{M} = \hat{M}^d$). Moreover, intertemporal consumption smoothing guarantees $\hat{C}_T = \hat{C}_T^d$. Then the above implies that

$$\hat{X} = \hat{X} - \frac{\beta}{1 - \beta} (\hat{X} - \hat{X})$$

must hold for any value of $\beta$, so that it must be the case that

$$\hat{X} = \hat{X},$$

i.e. the exchange rate immediately jumps to its long run value.