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ARE US SPILLOVERS POSITIVE OR NEGATIVE FOR MEXICO?

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Abstract

The aim of this thesis is to unveil the economic interrelations between the US and Mexico and how technology and monetary policy shocks in one country affect the other through spillover effects. We want to uncover the channels or transmission mechanisms in which the different shocks are propagated. For this, we develop a two-country DSGE model with incomplete international asset market, staggered price setting and asymmetry in both country's size. We find that under the baseline calibration the Mexican shocks don´t importantly affect the US endogenous variables, that a positive US technology shock has ambiguous spillover effects (which turn complementary if the central bank doesn't react to exchange rate fluctuations) and a US monetary policy shock has negative spillover effects. We also find that the country with the lower price stickiness can benefit more from a global productivity shock.

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Chapter 1

Introduction

In a growingly interconnected global economy, external shocks originating in advanced economies can have significant implications for emerging economies, often resulting in spillover effects that reverberate across borders. These spillovers can manifest in various forms, impacting financial markets, trade dynamics, and macroeconomic stability. Understanding the transmission mechanisms of these shocks is crucial for policymakers and market participants alike, as it enables them to anticipate, mitigate, and manage the potential repercussions on emerging economies. By examining the channels through which shocks propagate, this thesis aims to shed light on the complexities of global economic interdependencies and contribute to a more comprehensive understanding of the interconnectedness of economies worldwide.

One notable example of a technological shock with far-reaching spillover effects is the rapid advancement of information technology. Innovations in things like communication or automation originating in advanced economies have reshaped global production networks and supply chains, affecting emerging economies in profound ways.

Additionally, monetary policy shocks, such as the taper tantrum of 2013, have demonstrated the interconnectedness of global financial markets and the susceptibility of emerging economies to shifts in monetary policy stances by central banks of advanced economies. The taper tantrum, caused by concerns over the Federal Reserve's plans to scale back its quantitative easing program, led to capital outflows from emerging markets, currency depreciations, and increased borrowing costs. Countries with weaker economic fundamentals and higher external vulnerabilities experienced more negative effects, demonstrating the importance of sound domestic policies and effective macroeconomic management in buffering against external shocks.

Österholm & Zettelmeyer (2008) estimate that approximately 50% to 60% of the variation of GDP in Latin American countries is due to external shocks. This shows the importance to take appropiate policy measures to diminish the effects of foreign shocks. One way to do this is by policy coordination between advanced and emerging economies. Ostry and Ghosh (2016) point out that cooperation between central banks is worth pursuing to lessen the negative effects of volatile capital flows and uncertainty, although the potential gains are not very big.

The aim of this thesis is to unveil the economic interrelations between the US and Mexico and how technology and monetary policy shocks in one country affect the other through spillover effects. We want to uncover the channels or transmission mechanisms in which the different shocks are propagated and see if they are complementary, in the sense that a shock in one country affects the other in the same direction, or if they are competitive, in the sense that a shock in one country causes the relevant variables, such as output, to move on the opposite direction in the other country.

For this we develop a two country Dynamic Stochastic General Equilibrium (DSGE) model. In each country there habits a representative household that makes decisions about its consumption, working time, asset accumulation and capital investment. There is a competitive final good producing firm and monoponically competitive intermediate goods producing firms that produce a continuum of differentiatied goods and set prices as in Calvo (1983). The international asset market is assumed to be incomplete and the law of one price holds. The labor and rental capital markets in both countries are assumed to be perfectly competitive. The analysis looked at 5 shocks: a global productivity shock, a US productivity shock, a Mexico productivity shock and home and foreign interest rate shocks from the Mexico and the US. The model is log-linearized around a steady state and we use Dynare to solve it numerically.

We find that there are initially competitive spillover effects in Mexico originating from a positive productivity shock in the US, but they are counteracted (and even be turned into complementary) by more flexible prices in Mexico and if the central bank doesn't react to changes in the exchange rate through the Taylor rule. There are some differences in the effects derived from a global productivity shock, in particular we find that wages, labor demand, investment and output benefits the country with more flexible prices. There are also competitive spillover effects from a contractionary interest rate shock that originates in the US, but again its effect is diminished by a lower price stickiness. We find space for policy coordination to reduce the competitive policy spillover effects.

There is an extensive literature focusing on the benefits of coordination between monetary authorities. Hamada (1976) analyses a non-cooperative game between n countries, finding that Cournot and Stackelberg solutions are not Pareto efficient and that coordination, if possible, may improve the resulting equilibrium. He also finds that under flexible exchange rates, conflicts over the level of interest rates may occur and, in the adjustment process, beggar-my-neighbors policy can rise. On the other hand, Rogoff (1985) shows that monetary cooperation may be counterproductive because it elevates the efficacy of policy through a coordinated response, therefore increasing the incentives to incur in expansionary policies because the exchange rate fluctuations (which are the the reason agents incur in strategic behaviour) are minimized. This incentives are internalized by the rational wage setters, demanding a higher wage in the time consistent equilibrium. Continuing with the game theoretic literature, Laskar (1989), using a non cooperative game between two central banks, argues that the case of imposing a conservative central banker may be strengthened in the case of asymmetric shocks, but in the case of a symmetric shock, it is best to have a non-conservative central banker to take advantage of competitive fluctuations in the exchange rate. In this case, cooperation is understood as the appointment accross countries of central bankers with similar preferences for inflation.

More recently, Benigno (2002) analyses the strategic interaction between monetary policymakers through the lens of a micro-founded two country general equilibrium model. In this case, there is an incentive to use adjustments in the terms of trade to take advantage of the trade channel. He finds similar things as the game theoretic literature, such as a contractionary bias (beggar-thy-neighbor), inefficiency in the Nash equilibrium and the possibility of cooperation being counterproductive. Davoine and Molnar (2020) illustrate that capital-skill complementarity can result in substantial spillover effects, particularly highlighting that fiscal policy spillovers can be significant when monetary policy is nearing the zero lower bound constraint. Devereux et al. (2020), employing a calibrated DSGE model as the data generating process, perform optimal policy analysis for financially integrated economies using an identified SVAR. Their findings indicate that financial integration can enhance welfare when under policy coordination.

Finally, Bhattari et al. (2021) using a two country DSGE model and a VAR methodology conclude that monetary and fiscal policy shocks are competitive between the US (an advanced economy) and India (an emerging market), whereas domestic and global technology shocks, as well as exchange rate shocks, have complementary effects. This happens because technology boosts productivity in both countries, while policy shocks tend to attract foreign capital flows to the country with the higher rate of return. Therefore, policy shocks in advanced economies could lead to foreign capital inflows into emerging markets with associated large current account deficits. One important thing is that they argue that enhanced coordination of policies can help mitigate adverse cross-border spillovers.

The modeling framework adopted in this thesis is based on the Bhattari et al. (2021) two country DSGE model, which was calibrated for India and the US. However, there are two very important differences between the model of Bhattari et al. (2021). First, they assume that labor is the only factor of production and ignore capital accumulation and investment dynamics from the model. Second, they assume that all countries are of equal size. We rectify these deficiencies by introducing capital and investment spending into the production process and allow for asymmetry of country size. The motivation, therefore, is to add complexity in the possible transmission mechanisms that foreign shocks can have on emerging economies. Moreover, we calibrate the model to match US and Mexican economies.

This thesis is organized as follows. Chapter 2 develops the theoretical two country model. Chapter 3 presents the log-linearized version of the model around a particular steady state and explains the calibration. Chapter 4 presents the results from the impulse response analysis and performs a sensitivity analysis to judge the robustness of the model to changes in the key parameters. Finally, chapter 5 concludes.

Chapter 2

Model

2.1 Model

In this chapter the model is described. There are two countries inside a global economy denoted by home (H) and foreign (F). In each country there habits a representative household that makes decisions about its consumption, working time, asset accumulation and capital investment. There are a continuum of intermediate goods producing firms, and a representative final good producer. The representative household is the owner of all intermediate firms (which operate in a monopolistically competitive market) and physical capital, and makes all investment decisions. The international asset market is assumed to be incomplete and the law of one price holds. The model includes a staggered price setting for the intermediate goods producing firms. The representative final good producing firm operates in a competitive market and bundles the domestic and imported goods into a final good. The labor and rental capital markets in both countries are assumed to be perfectly competitive. An asterisk notation is used for foreign variables and parameters.

2.1.1 Final goods producers

There is a final good Z_t that is produced by a competitive firm that uses the inputs $Z_{H,t}$ and $Z_{F,t}$ and transforms them using a CES aggregator index:

$$Z_t = \left[(1-a)^{\frac{1}{\rho}} Z_{H,t}^{\frac{\rho-1}{\rho}} + a^{\frac{1}{\rho}} Z_{F,t}^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}, \tag{2.1}$$

$$Z_t^* = \left[a^{*\frac{1}{\rho^*}} (Z_{H,t}^*)^{\frac{\rho^*-1}{\rho^*}} + (1-a^*)^{\frac{1}{\rho^*}} (Z_{F,t}^*)^{\frac{\rho^*-1}{\rho^*}} \right]^{\frac{\rho^*}{\rho^*-1}}, \tag{2.2}$$

where $\rho, \rho^* > 0$ are the elasticity of substitution between the home and imported intermediate goods from the home and foreign country respectively. There is asymmetry relating to the size of each country. Without loss of generality, the home country size is assumed to be of measure n and the foreign country is of measure $1-n$, so that the sum of the population in the global economy is normalized to one. The parameters a and a^* measure each country's preferences for imported goods, which depends on the size of the foreign country and the degree of trade openness $b \in (0,1)$. Thus, the parameter $a \equiv (1-n)b$ captures home country preferences for imported goods and $a^* \equiv nb$ captures the foreign country preferences for home (also imported) goods.

Inputs are defined using a CES aggregator for the continuum of intermediate goods:

$$\begin{aligned} Z_{H,t} &= \left(\left(\frac{1}{n} \right)^{\frac{1}{\epsilon}} \int_0^1 Z_{H,t}(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}, \\ Z_{F,t} &= \left(\left(\frac{1}{1-n} \right)^{\frac{1}{\epsilon}} \int_0^1 Z_{F,t}(i^*)^{\frac{\epsilon-1}{\epsilon}} di^* \right)^{\frac{\epsilon}{\epsilon-1}}, \end{aligned} \tag{2.3}$$

$$\begin{aligned} Z_{H,t}^* &= \left(\left(\frac{1}{n} \right)^{\frac{1}{\epsilon}} \int_0^1 Z_{H,t}^*(i)^{\frac{\epsilon^*-1}{\epsilon^*}} di \right)^{\frac{\epsilon^*}{\epsilon^*-1}}, \\ Z_{F,t}^* &= \left(\left(\frac{1}{1-n} \right)^{\frac{1}{\epsilon}} \int_0^1 Z_{F,t}^*(i^*)^{\frac{\epsilon^*-1}{\epsilon^*}} di^* \right)^{\frac{\epsilon^*}{\epsilon^*-1}}, \end{aligned} \tag{2.4}$$

where $\epsilon, \epsilon^* > 1$ are the elasticities of substitution among the intermediate goods from the home (foreign) country and $Z_{H,t}(i)$ and $Z_{F,t}(i^*)$ are the home quantities of good i and quantities of good i*, respectively, while $Z^*_{H,t}(i)$ and $Z^*_{F,t}(i^*)$ are the foreign quantities of good i and good i^*, respectively. The aggregate demand conditions for home and foreign goods are obtained through cost minimization:

$$Z_{H,t} = (1-a)\left(\frac{P_{H,t}}{P_t}\right)^{-\rho} Z_t, \quad Z_{F,t} = a\left(\frac{P_{F,t}}{P_t}\right)^{-\rho} Z_t, \tag{2.5}$$

$$Z^*_{H,t} = a^*\left(\frac{P^*_{H,t}}{P^*_t}\right)^{-\rho^*} Z^*_t, \quad Z^*_{F,t} = (1-a^*)\left(\frac{P^*_{F,t}}{P^*_t}\right)^{-\rho^*} Z^*_t, \tag{2.6}$$

and the demand for the individual goods i and i^* are given by:

$$Z_{H,t}(i) = \frac{1}{n}\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} Z_{H,t}, \quad Z_{F,t}(i^*) = \frac{1}{1-n}\left(\frac{P_{F,t}(i^*)}{P_{H,t}}\right)^{-\epsilon} Z_{H,t}, \tag{2.7}$$

$$Z^*_{H,t}(i) = \frac{1}{n}\left(\frac{P^*_{H,t}(i)}{P^*_{H,t}}\right)^{-\epsilon *} Z^*_{H,t}, \quad Z^*_{F,t}(i^*) = \frac{1}{1-n}\left(\frac{P^*_{F,t}(i^*)}{P^*_{F,t}}\right)^{-\epsilon *} Z^*_{H,t}. \tag{2.8}$$

The aggregate price indices for the home and foreign country are given by:

$$P_t = \left[(1-a)P_{H,t}^{1-\rho} + aP_{F,t}^{1-\rho}\right]^{\frac{1}{1-\rho}}, \tag{2.9}$$

$$P^*_t = \left[a^* P_{H,t}^{*1-\rho^*} + (1-a^*)P_{F,t}^{*1-\rho^*}\right]^{\frac{1}{1-\rho^*}}. \tag{2.10}$$

Finally, the indices for home-produced and imported goods, $P_{H,t}$ and $P_{F,t}$ and the foreign country counterparts are as follows:

$$P_{H,t} = \left[\frac{1}{n}\int_0^1 P_{H,t}(i)^{1-\epsilon} di\right]^{\frac{1}{1-\epsilon}}, \quad P_{F,t} = \left[\frac{1}{1-n}\int_0^1 P_{F,t}(i^*)^{1-\epsilon} di^*\right]^{\frac{1}{1-\epsilon}}, \tag{2.11}$$

$$P^*_{H,t} = \left[\frac{1}{n}\int_0^1 P^*_{H,t}(i)^{1-\epsilon^*} di\right]^{\frac{1}{1-\epsilon^*}}, \quad P^*_{F,t} = \left[\frac{1}{1-n}\int_0^1 P^*_{F,t}(i^*)^{1-\epsilon^*} di^*\right]^{\frac{1}{1-\epsilon^*}}. \tag{2.12}$$

The model assumes the law of one price (LOOP), which requires the holding of the following conditions:

$$P_{H,t} = s_t P^*_{H,t} \quad \text{and} \quad P^*_{F,t} = \frac{P_{F,t}}{s_t} \tag{2.13}$$

where s_t is the nominal exchange rate. Under this assumption, Purchasing Power Parity (PPP) holds only when there is no home bias ($a = a^* = 0.5$). We can see this by defining

$$\varepsilon_t = \frac{s_t P^*_t}{P_t} \tag{2.14}$$

as the real exchange rate and noting that if we asume $\rho = \rho^*$ the following result holds from equations (2.9) and (2.10):

$$\begin{aligned}\varepsilon_t^{1-\rho} = \frac{(s_t P^*_t)^{1-\rho}}{P_t^{1-\rho}} &= \frac{a^*(s_t P^*_{H,t})^{1-\rho} + (1-a^*)(s_t P^*_{F,t})^{1-\rho}}{(1-a)P_{H,t}^{1-\rho} + aP_{F,t}^{1-\rho}} \\ &= \frac{a^*(P_{H,t})^{1-\rho} + (1-a^*)(s_t P^*_{F,t})^{1-\rho}}{(1-a)P_{H,t}^{1-\rho} + a(s_t P^*_{F,t})^{1-\rho}},\end{aligned}$$

where the last equality follows from the LOOP assumption. By inspection, it is easy to see that the PPP condition holds if $a = a^* = 0.5$ when both countries share the same elasticity of substitution between domestically-produced and imported goods, $\rho = \rho^*$. However, because the model assumes asymmetric size between countries note that there is no b strictly in the interval $(0, 1)$ that satisfies at the same time both conditions: $a \equiv (1 - n)b = 0.5$ and $a^* \equiv nb = 0.5$, therefore the PPP condition never holds in this model and there is always home bias.

As a last point in this section, the terms of trade are defined as:

$$\begin{aligned} T_t &= P_{F,t}/P_{H,t}, \\ T^*_t &= P^*_{F,t}/P^*_{H,t}. \end{aligned} \tag{2.15}$$

2.1.2 Intermediate firms

There are a continuum of home intermediate firms indexed by $i \in (0,1)$ and foreign intermediate firms indexed by $i^* \in (0,1)$ with access to the same production technology, which is represented by the country specific production functions:

$$\begin{aligned} Y_t(i) &= A_{w,t} A_t K_t(i)^{\alpha} N_t(i)^{1-\alpha}, \\ Y_t^*(i^*) &= A_{w,t} A_t^* K_t^*(i^*)^{\alpha^*} N_t^*(i^*)^{1-\alpha^*}, \end{aligned} \tag{2.16}$$

where $A_{w,t}$ is the global technology shifter, which is common to all firms in both countries, and A_t and A_t^* are the home and foreign country technology shifters, respectively. $N_t(i)$ and $K_t(i)$ are repectively the labor and capital used to yield the intermediate good $Y_t(i)$ in the home economy. $N_t^*(i^*)$, $K_t^*(i^*)$ and $Y_t^*(i^*)$ are the foreign country counterparts. Given the real wage (W_t) and the rental price of capital (V_t), in the home country, cost minimization yields the following optimality conditions:

$$\begin{aligned} mc_t \frac{\partial Y_t(i)}{\partial K_t(i)} &= \frac{V_t}{P_{H,t}} \\ \Rightarrow V_t &= mc_t \frac{P_{H,t}}{P_t} A_{w,t} A_t \alpha \left(\frac{N_t(i)}{K_t(i)} \right)^{1-\alpha}; \end{aligned} \tag{2.17}$$

$$\begin{aligned} mc_t \frac{\partial Y_t(i)}{\partial N_t(i)} &= \frac{W_t}{P_{H,t}} \\ \Rightarrow W_t &= mc_t \frac{P_{H,t}}{P_t} A_{w,t} A_t (1-\alpha) \left(\frac{K_t(i)}{N_t(i)} \right)^{\alpha}, \end{aligned} \tag{2.18}$$

where $mc_t = \frac{MC_t}{P_{H,t}}$ is the real marginal cost and MC_t denotes nominal marginal cost. Similarly, the following optimality conditions for the foreign country are obtained:

$$\begin{aligned} mc_t^* \frac{\partial Y_t^*(i^*)}{\partial K_t^*(i^*)} &= \frac{V_t^*}{P_{F,t}^*} \\ \Rightarrow V_t^* &= mc_t^* \frac{P_{F,t}^*}{P_t^*} A_{w,t} A_t^* \alpha^* \left(\frac{N_t^*(i^*)}{K_t^*(i^*)} \right)^{1-\alpha^*}; \end{aligned} \tag{2.19}$$

$$mc_t^* \frac{\partial Y_t^*(i)}{\partial N_t^*(i)} = \frac{W_t^*}{P_{F,t}^*}$$
$$\Rightarrow W_t^* = mc_t^* \frac{P_{F,t}^*}{P_t^*} A_{w,t} A_t^* (1-\alpha^*) \left(\frac{K_t^*(i^*)}{N_t^*(i^*)} \right)^{\alpha^*}. \tag{2.20}$$

Intermediate firms set prices according to the Calvo (1983) mechanism. Firms can change their own price in period t with a probability of $1-\theta$ independently of past history. A home firm that can change its price on period t chooses its own price $P_{H,t}(i)$ that maximizes its discounted value of profits. This means that the price will be the same on period $t+s$ with probability θ^s. Since all firms that are chosen to change its price at a given period will set the same price, the index i can be removed. Therefore, the price setting problem reads:

$$\max_{P'_{H,t}} E_t \sum_{s=0}^{\infty} \theta^s M_{t,t+s} \left[(P'_{H,t} - MC_{t+s|t})(Z_{H,t+s|t} + Z^*_{H,t+s|t}) \right]$$
$$s.t \quad Z_{H,t+s|t} + Z^*_{H,t+s|t} = \left(\frac{P'_{H,t}}{P_{H,t+s}} \right)^{-\epsilon} (Z_{H,t+s} + Z^*_{H,t+s}),$$

where $M_{t,t+s} = \beta^s \frac{C_{t+s}^{-\sigma}}{C_t^{-\sigma}} \frac{P_t}{P_{t+s}}$ is the stochastic discount factor of the home country firms. Then, the first order condition is obtained by substituting the constraint into the objective function:

$$E_t \sum_{s=0}^{\infty} \theta^s M_{t,t+s} (Z_{H,t+s} + Z^*_{H,t+s}) P^{\epsilon}_{H,t+s} [(1-\epsilon) P'^{-\epsilon}_{H,t} + \epsilon MC_{t+s} P'^{-\epsilon-1}_{H,t}] = 0$$
$$\Rightarrow P'_{H,t} = \frac{\epsilon}{\epsilon - 1} \left[\frac{E_t \sum_{s=0}^{\infty} \theta^s M_{t,t+s} (Z_{H,t+s} + Z^*_{H,t+s}) P^{\epsilon}_{H,t+s} MC_{t+s}}{E_t \sum_{s=0}^{\infty} \theta^s M_{t,t+s} (Z_{H,t+s} + Z^*_{H,t+s}) P^{\epsilon}_{H,t+s}} \right]. \tag{2.21}$$

Note that without pricing frictions, i.e. $\theta = 0$, the optimal price is a constant markup, $\frac{\epsilon}{\epsilon-1}$, over nominal marginal cost.

Since there are a continuum -or infinite number- of households, the probabilities are equivalent to proportions of firms changing price, so the law of motion of the home goods price index is given by:

$$P_{H,t}^{1-\epsilon} = \theta P_{H,t-1}^{1-\epsilon} + (1-\theta) P_{H,t}^{\prime 1-\epsilon}. \tag{2.22}$$

Similarly, for the foreign country, the solution to the price setting problem is

$$P_{F,t}^{*\prime} = \frac{\epsilon^*}{\epsilon^* - 1} \left[\frac{E_t \sum_{s=0}^{\infty} (\theta^*)^s M_{t,t+s}^* (Z_{F,t+s}^* + Z_{F,t+s}) P_{F,t+s}^{*\epsilon^*} MC_{t+s}^*}{E_t \sum_{s=0}^{\infty} (\theta^*)^s M_{t,t+s}^* (Z_{F,t+s}^* + Z_{F,t+s}) P_{F,t+s}^{*\epsilon^*}} \right], \tag{2.23}$$

where $M_{t,t+s}^* = \beta^{*s} \frac{C_{t+s}^{*-\sigma^*}}{C_t^{*-\sigma^*}} \frac{P_t^*}{P_{t+s}^*}$ is the foreign stochastic discount factor. Then, the law of motion of the foreign goods price index is given by:

$$P_{F,t}^{*1-\epsilon} = \theta^* P_{F,t-1}^{*1-\epsilon^*} + (1-\theta^*) P_{F,t}^{*\prime 1-\epsilon^*}. \tag{2.24}$$

2.1.3 Households

There is a representative household in each country whose preferences are represented by the utility functions:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t), \quad E_0 \sum_{t=0}^{\infty} (\beta^*)^t U^*(C_t^*, N_t^*), \tag{2.25}$$

where C_t and C_t^* are consumption indexes from the home and foreign country respectively and $\beta, \beta^* \in (0,1)$ are the home and foreign discount factors. The period utility function is assumed to be

$$U(C_t, N_t) = \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\psi}}{1+\psi} \right), \tag{2.26}$$

$$U^*(C_t^*, N_t^*) = \left(\frac{(C_t^*)^{1-\sigma^*}}{1-\sigma^*} - \frac{N_t^{*1+\psi^*}}{1+\psi^*} \right), \tag{2.27}$$

where $1 \neq \sigma, \sigma^* \geq 0$ are the relative risk aversion coefficients between current and future consumption and $\psi, \psi^* \geq 0$ are the inverse of elasticities of labor supply.

The households are the owners of capital and make the investment decisions in each country, I_t and I_t^*. The price of capital is assumed to be the same as the price of consumption goods, P_t and P_t^*. The law of motion of capital is given by:

$$\begin{aligned} K_{t+1} &= (1-\delta)K_t + I_t, \\ K_{t+1}^* &= (1-\delta^*)K_t^* + I_t^*, \end{aligned} \tag{2.28}$$

where $\delta, \delta^* \in (0,1)$ are the depreciation rates of capital in each country.

Similar to Benigno and Thoenissen (2008), and McKnight and Povoledo (2022), I assume asymmetry in the international asset market structure. Foreign households can buy one period bonds from the home and foreign country, $B_{H,t}^*$ and $B_{F,t}^*$ respectively, but households in the home country can only buy domestic one period bonds, $B_{H,t}$. Allowing the Home agent to also purchase foreign bonds would introduce an additional optimality condition with no change in the results. There is a transaction cost for adjusting the bond $B_{H,t}^*$ for the foreign agent $\phi()$, where ϕ is a positive, twice differentiable function and decreasing on foreign bond holdings, $\phi' \leq 0$. It is also assumed that $\phi(0) = 1$.[1]

Given the assumptions above, the home country budget constraint can be expressed as

$$P_t C_t + P_t I_t + \frac{B_{H,t}}{R_t} \leq B_{H,t-1} + P_t W_t N_t + P_t V_t K_t + \Pi_t, \tag{2.29}$$

where W_t is the real wage, N_t is the working time, V_t is the real rental rate of capital and Π_t are the profits from owning the intermediate good firms.

[1]The bond transaction cost needs to be introduced to ensure that bond holdings are stationary and a unique steady state solution exists, as discussed by Benigno & Thoenissen (2008) and McKnight & Povoledo (2022).

The foreign country budget constraint is:

$$P_t^* C_t^* + P_t^* I_t^* + \frac{B_{F,t}^*}{R_t^*} + \frac{B_{H,t}^*}{s_t R_t \phi(B_{H,t}^*)} \leq B_{F,t-1}^* + \frac{B_{H,t-1}^*}{s_t} + P_t^* W_t^* N_t^* + P_t^* V_t^* K_t^* + \Pi_t^*. \quad (2.30)$$

where R_t and R_t^* are the home and foreign nominal interest rates, repectively.

Each country maximizes the representative household utility subject to its own budget constraint and the law of motion of capital. To solve the home household problem we substitute the law of motion of capital (2.28) into the budget constraint (2.29), which resuts in the Lagrangian:

$$\max E_t \sum_{t=0}^{\infty} \beta^t \Bigg[\Bigg[\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\psi}}{1+\psi} \\ - \lambda_t \Bigg[P_t C_t + P_t (K_{t+1} - (1-\delta) K_t) + \frac{B_{H,t}}{R_t} - B_{H,t-1} - P_t W_t N_t - P_t V_t K_t - \Pi_t \Bigg] \Bigg] \Bigg],$$

where λ_t is the budget constraint's Lagrange multiplier.

There are four first order conditions:

$$\frac{\partial \mathcal{L}}{\partial C_t} = C_t^{-\sigma} - \lambda_t P_t = 0$$
$$\Rightarrow C_t^{-\sigma} = \lambda_t P_t, \quad (2.31)$$

$$\frac{\partial \mathcal{L}}{\partial N_t} = -N_t^{\psi} + \lambda_t P_t W_t = 0$$
$$\Rightarrow W_t = \frac{N_t^{\psi}}{P_t \lambda_t}, \quad (2.32)$$

$$\frac{\partial \mathcal{L}}{\partial B_{H,t}} = -\lambda_t \frac{1}{R_t} + E_t \left[\beta \lambda_{t+1} \right] = 0$$
$$\Rightarrow \frac{1}{R_t} = \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \right], \quad (2.33)$$

$$\frac{\partial \mathcal{L}}{\partial K_{t+1}} = -\lambda_t P_t - \beta E_t \left[\lambda_{t+1}(-(1-\delta)P_{t+1} - P_{t+1}V_{t+1})\right] = 0$$

$$\Rightarrow \lambda_t P_t = \beta E_t[\lambda_{t+1}((1-\delta)P_{t+1} + P_{t+1}V_{t+1})]. \tag{2.34}$$

Combining (2.31) and (2.32), we get the expression

$$W_t = N_t^{\psi} C_t^{\sigma}. \tag{2.35}$$

Using the consumption and domestic bond holdings first order conditions (2.31) and (2.33) the consumption Euler equation is obtained:

$$\frac{1}{R_t} = \beta E_t \left[\frac{C_{t+1}^{-\sigma}}{C_t^{-\sigma}} \frac{P_t}{P_{t+1}}\right], \tag{2.36}$$

and using (2.31) and (2.34) we arrive to the capital accumulation Euler equation:

$$C_t^{-\sigma} = \beta E_t[C_{t+1}^{-\sigma}((1-\delta) + V_{t+1})]. \tag{2.37}$$

Meanwhile, the foreign household problem is expressed as:

$$\max E_t \sum_{t=0}^{\infty} \beta^{*t} \Bigg[\Bigg[\frac{C_t^{*1-\sigma^*}}{1-\sigma^*} - \frac{N_t^{*1+\psi^*}}{1+\psi^*}$$
$$- \lambda_t^* \Bigg[P_t^* C_t^* + P_t^*(K_{t+1}^* - (1-\delta^*)K_t^*) + \frac{B_{F,t}^*}{R_t^*} + \frac{s_t^{-1} B_{H,t}^*}{R_t \phi(B_{H,t}^*)}$$
$$- B_{H,t-1}^* - s_t^{-1} B_{F,t-1}^* - P_t^* W_t^* N_t^* - P_t^* V_t^* K_t^* - \Pi_t^*\Bigg]\Bigg].$$

There are five first order conditions:

$$\frac{\partial \mathcal{L}}{\partial C_t^*} = C_t^{*-\sigma^*} - \lambda_t^* P_t^* = 0$$

$$\Rightarrow C_t^{*-\sigma^*} = \lambda_t^* P_t^*, \tag{2.38}$$

$$\frac{\partial \mathcal{L}}{\partial N_t^*} = -N_t^{*\psi^*} + \lambda_t^* P_t^* W_t^* = 0$$
$$\Rightarrow W_t^* = \frac{N_t^{*\psi^*}}{P_t^* \lambda_t^*}, \tag{2.39}$$

$$\frac{\partial \mathcal{L}}{\partial B_{F,t}^*} = -\lambda_t^* \frac{1}{R_t^*} + E_t\left[\beta^* \lambda_{t+1}^*\right] = 0$$
$$\Rightarrow \frac{1}{R_t^*} = \beta^* E_t\left[\frac{\lambda_{t+1}^*}{\lambda_t^*}\right], \tag{2.40}$$

$$\frac{\partial \mathcal{L}}{\partial B_{H,t}^*} = -\lambda_t^* \frac{s_t^{-1}}{R_t \phi(B_{H,t}^*)} + \beta^* E_t\left[\lambda_{t+1} s_{t+1}^{-1}\right] = 0$$
$$\Rightarrow \frac{1}{R_t} = \beta^* E_t\left[\frac{\lambda_{t+1}^* s_t}{\lambda_t^* s_{t+1}}\right], \tag{2.41}$$

$$\frac{\partial \mathcal{L}}{\partial K_{t+1}^*} = -\lambda_t^* P_t^* - \beta^* E_t\left[\lambda_{t+1}^*(-(1-\delta^*)P_{t+1}^* - P_{t+1}^* V_{t+1}^*)\right] = 0$$
$$\Rightarrow \lambda_t^* P_t^* = \beta^* E_t[\lambda_{t+1}^*((1-\delta^*)P_{t+1}^* + P_{t+1}^* V_{t+1}^*)]. \tag{2.42}$$

Two consumption Euler equations can be derived using the consumption, home and foreign bond holdings first order conditions (2.38, 2.41 and 2.40, respectively):

$$\frac{1}{R_t} = \beta^* E_t\left[\phi(B_{H,t}^*)\frac{C_{t+1}^{*-\sigma^*}}{C_t^{*-\sigma^*}}\frac{P_t^*}{P_{t+1}^*}\frac{s_t}{s_{t+1}}\right], \tag{2.43}$$

$$\frac{1}{R_t^*} = \beta^* E_t\left[\frac{C_{t+1}^{*-\sigma^*}}{C_t^{*-\sigma^*}}\frac{P_t^*}{P_{t+1}^*}\right]. \tag{2.44}$$

Using the above equations, the following interest rate parity condition can be derived:

$$\frac{R_t}{R_t^*} = \frac{E_t\left[\frac{C_{t+1}^{*-\sigma^*}}{P_{t+1}^*}\right]}{\phi(B_{H,t}^*)E_t\left[\frac{C_{t+1}^{*-\sigma^*}}{P_{t+1}^*}\frac{s_t}{s_{t+1}}\right]}. \tag{2.45}$$

Combining (2.38) and (2.39) gives the labor supply condition:

$$W_t^* = N_t^{*\psi^*} C_t^{*\sigma^*}. \tag{2.46}$$

Finally, combining (2.38) and (2.42) we arrive at the foreign Euler equation of capital accumulation:

$$C_t^{*-\sigma^*} = \beta^* E_t[C_{t+1}^{*-\sigma^*}((1-\delta^*) + V_{t+1}^*)]. \tag{2.47}$$

2.1.4 Monetary policy

The monetary policy rule uses the nominal interest rate and responds to deviations from the steady state inflation rate, output and nominal exchange rate, Therefore it takes the following log-linearized form:

$$\hat{R}_t = \omega_R \hat{R}_{t-1} + (1-\omega_R)[\omega_\pi \hat{\pi}_t + \omega_y \hat{y}_t + \omega_s \Delta \hat{s}_t] + u_t, \tag{2.48}$$

where u_t is an interest rate shock, $\omega_R \in (0,1)$ is the interest rate smoothing parameter, ω_π, ω_y and ω_s are the sensitivities to inflation, output and exchange rate deviations (from the steady state), respectively and $\Delta \hat{s}_t = \hat{s}_t - \hat{s}_{t-1}$. Both countries conduct their monetary policy independently of each other, so the foreign country policy rule takes the form:

$$\hat{R}_t^{\,*} = \omega_R^* \hat{R}_{t-1}^* + (1-\omega_R^*)[\omega_\pi^* \hat{\pi}_t^* + \omega_y^* \hat{y}_t^* - \omega_s^* \Delta \hat{s}_t] + u_t^*, \tag{2.49}$$

where the parameters are similar to the home country interest-rate rule.

2.1.5 Market clearing

Market clearing for the home and foreign country requires

$$Y_t(i) = Z_{H,t}(i) + Z_{H,t}^*(i), \quad Y_t^*(i) = Z_{F,t}^*(i) + Z_{F,t}(i) \quad \forall i, t. \tag{2.50}$$

Using the aggregate demand for the home and foreign countries (2.5 and 2.6), the home and foreign demands of good i (2.7 and 2.8) and the LOOP equation (2.13), we get:

$$\begin{aligned} Y_t(i) &= \frac{1}{n}\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon}(Z_{H,t}+Z^*_{H,t}), \\ Y^*_t(i) &= \frac{1}{1-n}\left(\frac{P^*_{F,t}(i)}{P^*_{F,t}}\right)^{-\epsilon^*}(Z_{F,t}+Z^*_{F,t}). \end{aligned} \tag{2.51}$$

Aggregating across intermediate firms and using the definition of the price indices (2.11 and 2.12), the last set of equations turn into

$$\begin{aligned} nY_t &= Z_{H,t}+Z^*_{H,t}, \\ (1-n)Y^*_t &= Z_{F,t}+Z^*_{F,t}. \end{aligned} \tag{2.52}$$

It is also required that domestic supply equals domestic demand in the final good market in each country:

$$\begin{aligned} Z_t &= C_t + I_t, \\ Z^*_t &= C^*_t + I^*_t. \end{aligned} \tag{2.53}$$

For bond market clearing it is required for the internationally traded bond that

$$B_{H,t} + B^*_{H,t} = 0 \quad \text{and} \quad B^*_{F,t} = 0. \tag{2.54}$$

From the good i equilibrium condition (2.51) and the production function (2.16) we can derive the aggregate production function for the home country:

$$\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon}(Z_{H,t}+Z^*_{H,t}) = A_{w,t}A_tK_t(i)^{\alpha}N_t(i)^{1-\alpha}.$$

Integrating over the intermediate good-producing firms we have

$$\begin{aligned} &(Z_{H,t}+Z^*_{H,t})\int_0^1\left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon}di = A_{w,t}A_t\int_0^1 K_t(i)^{\alpha}N_t(i)^{1-\alpha}di \\ &\Rightarrow Y_t = \frac{A_{w,t}A_tK_t^{\alpha}N_t^{1-\alpha}}{d_t} \end{aligned} \tag{2.55}$$

where $d_t = \int_0^1 \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon} di$ is the degree of price dispersion in the home country. The degree of price dispersion can be expressed as:

$$d_t = \int_0^{1-\theta} \left(\frac{P'_{H,t}}{P_{H,t}}\right)^{-\epsilon} di + \int_{1-\theta}^{1} \left(\frac{P_{H,t-1}(i)}{P_{H,t}}\right)^{-\epsilon} di,$$

which implies that the evolution of price dispersion obeys the following equation:

$$d_t = (1-\theta)\left(\frac{P'_{H,t}}{P_{H,t}}\right)^{-\epsilon} + \theta \pi_{H,t}^{\epsilon} d_{t-1}, \tag{2.56}$$

where $\pi_{H,t} = \frac{P_{H,t}}{P_{H,t-1}}$. Similarly, for the foreign country we have:

$$Y_t^* = \frac{A_{w,t} A_t^* K_t^{*\alpha^*} N_t^{*1-\alpha^*}}{d_t^*}, \tag{2.57}$$

$$d_t^* = (1-\theta^*)\left(\frac{P_{F,t}^{*\prime}}{P_{F,t}^*}\right)^{-\epsilon^*} + \theta^* \pi_{F,t}^{*\epsilon^*} d_{t-1}^*, \tag{2.58}$$

with $d_t^* = \int_0^1 \left(\frac{P_{F,t}^*(i^*)}{P_{F,t}^*}\right)^{-\epsilon^*} di^*$ and $\pi_{F,t}^* = \frac{P_{F,t}^*}{P_{F,t-1}^*}$.

2.1.6 Equilibrium

Given an initial allocation of K_0, K_0^*, $B_{H,0}$, $B_{H,0}^*$, $B_{F,0}^*$, productivity shocks: A_t, A_t^*, $A_{w,t}$ and interest rate shocks: u_t, u_t^*, an equilibrium for the global economy consists of:

- A set of 19 allocations: $\{C_t, C_t^*, Z_t, Z_t^*, Z_{H,t}, Z_{F,t}, Z_{H,t}^*, Z_{F,t}^*, I_t, I_t^*, N_t, N_t^*, K_t, K_t^*, B_{H,t}, B_{H,t}^*, B_{F,t}^*, Y_t, Y_t^*\}$.

- A set of 21 prices: $\{P_t, P_t^*, P_{H,t}, P_{H,t}^*, P_{F,t}, P_{F,t}^*, P'_{H,t}, P_{F,t}^{*\prime}, R_t, R_t^*, W_t, W_t^*, V_t, V_t^*, MC_t, MC_t^*, \varepsilon_t, T_t, T_t^*, d_t, d_t^*\}$.

The allocations and prices must jointly satisfy the following 40 conditions:

i. the home and foreign household budget constraints (2.29) and (2.30), and optimality conditions (2.35)-(2.37) and (2.44)-(2.47).

ii. the home and foreign intermediate goods producing firms optimality conditions (2.17)-(2.20) and the optimal price setting equations (2.21)-(2.24).

iii. the home and foreign final good producing firms optimality conditions (2.5)-(2.6).

iv. The aggregate production functions and laws of motion for price dispersion and capital accumulation (2.28) and (2.55)-(2.58).

v. Market clearing conditions (2.52)-(2.54).

vi. Monetary policy rules (2.48) and (2.49).

vii. The definition of the real exchange rate, the terms of trade, and the LOOP (2.14), (2.15) and (2.13).

Chapter 3

Linearization and model parametrization

3.1 Log-linearization

To solve the model numerically, the set of equations is log-linearized around a symmetric zero inflation steady state, where the terms of trade and nominal exchange rate is equal to one in the steady state in both countries and bond holdings are zero (i.e. trade is balanced). We assume $\beta = \beta^*$, therefore the steady state interest rate is the same in both countries. In this symmetric steady state, it can be shown that $Y^{ss} = Z^{ss}$ and $Y^{*ss} = Z^{*ss}$ and the domestic price is equal to the markup over marginal costs. Moreover, the following results hold in the steady state:

$$\begin{array}{lll}
\dfrac{Z_H^{ss}}{Y^{ss}} = 1\text{–}a; & \dfrac{I^{ss}}{K^{ss}} = \delta; & \\
\dfrac{Z_F^{ss}}{Y^{ss}} = a; & \dfrac{I^{*ss}}{K^{*ss}} = \delta^*; & R^{ss} = \dfrac{1}{\beta}; \\
\dfrac{Z_H^{*ss}}{Y^{*ss}} = a^*; & V^{ss} = \dfrac{1}{\beta} - (1-\delta); & R^{*ss} = \dfrac{1}{\beta^*}. \\
\dfrac{Z_F^{*ss}}{Y^{*ss}} = 1\text{–}a^*; & V^{*ss} = \dfrac{1}{\beta^*} - (1-\delta^*); &
\end{array}$$

In what follows, a hat notation is used to represent log deviations from the steady state. The steady state values are represented by a "ss" superscript. The resulting log-linear model is shown next.

3.1.1 Final good sector

- Price index

$$\hat{\pi}_t = \hat{\pi}_{H,t} + (1-n)b(\hat{T}_t - \hat{T}_{t-1}) \tag{3.1}$$

$$\hat{\pi}^*_t = \hat{\pi}^*_{F,t} - nb(\hat{T}_t - \hat{T}_{t-1}) \tag{3.2}$$

- Aggregate demands

$$\hat{Z}_{H,t} = \rho(1-n)b\hat{T}_t + \hat{Z}_t \tag{3.3}$$

$$\hat{Z}_{F,t} = -\rho[1-(1-n)b]\hat{T}_t + \hat{Z}_t \tag{3.4}$$

$$\hat{Z}^*_{H,t} = \rho^*(1-nb)\hat{T}_t + \hat{Z}^*_t \tag{3.5}$$

$$\hat{Z}^*_{F,t} = -\rho^* nb\hat{T}_t + \hat{Z}^*_t \tag{3.6}$$

To derive these conditions, the log-linearized terms of trade equations (2.15) are substituted into the log-linearized price equations (2.9) and (2.10). Then, noting that the following four conditions hold:

$$\hat{P}_t - \hat{P}_{H,t} = aT_t,$$

$$\hat{P}_t^* - \hat{P}_{F,t}^* = a^* T_t^*,$$

$$\hat{P}_t - \hat{P}_{F,t} = -(1-a)\hat{T}_t,$$

$$\hat{P}_t^* - \hat{P}_{H,t}^* = -(1-a^*)T_t^*,$$

we can eliminate the prices in the previous conditions and represent the aggregate demands with the home and foreign terms of trade. Then, using the log-linearized equations of the LOOP, we get:

$$\hat{T}_t = \hat{P}_{F,t} - \hat{P}_{H,t}$$

$$\Rightarrow \hat{T}_t = \hat{s}_t + \hat{P}_{F,t}^* - (\hat{s}_t + \hat{P}_{H,t}^*)$$

$$\Rightarrow \hat{T}_t = \hat{P}_{F,t}^* - \hat{P}_{H,t}^*$$

$$\Rightarrow \hat{T}_t = -(\hat{P}_{H,t}^* - \hat{P}_{F,t}^*)$$

$$\Rightarrow \hat{T}_t = -\hat{T}_t^*,$$

So we can express the foreign terms of trade in terms of the home terms of trade. Then by expressing a and a^* in terms of n and b we finally get the log-linearized equations above.

3.1.2 Intermediate goods sector

- Price setting problem (New Keynesian Philips Curve)

$$\hat{\pi}_{H,t} = \frac{(1-\theta)(1-\beta\theta)}{\theta}\hat{mc}_t + \beta E_t[\hat{\pi}_{H,t+1}] \tag{3.7}$$

$$\hat{\pi}_{F,t}^* = \frac{(1-\theta^*)(1-\beta^*\theta^*)}{\theta^*}\hat{mc}_t^* + \beta^* E_t[\hat{\pi}_{F,t+1}^*] \tag{3.8}$$

- Intermediate firms optimality conditions

$$\hat{V}_t = \hat{mc}_t - (1-n)b\hat{T}_t - \hat{K}_t + \hat{Y}_t \tag{3.9}$$

$$\hat{V}_t^* = \hat{mc}_t^* + nb\hat{T}_t - \hat{K}_t^* + \hat{Y}_t^* \tag{3.10}$$

$$\hat{W}_t = \hat{mc}_t - (1-n)b\hat{T}_t - \hat{N}_t + \hat{Y}_t \tag{3.11}$$

$$\hat{W}_t^* = \hat{mc}_t^* + nb\hat{T}_t - \hat{N}_t^* + \hat{Y}_t^* \tag{3.12}$$

3.1.3 Households

- Capital accumulation

$$\hat{K}_{t+1} = (1-\delta)\hat{K}_t + \delta\hat{I}_t \tag{3.13}$$

$$\hat{K}_{t+1}^* = (1-\delta^*)\hat{K}_t^* + \delta^*\hat{I}_t^* \tag{3.14}$$

- Home country optimality conditions

$$\sigma E_t[\hat{C}_{t+1}] - \sigma\hat{C}_t = \hat{R}_t - E_t[\hat{\pi}_{t+1}] \tag{3.15}$$

$$\sigma E_t[\hat{C}_{t+1}] - \sigma\hat{C}_t = [1-\beta(1-\delta)]E_t[\hat{V}_{t+1}] \tag{3.16}$$

$$\hat{W}_t = \sigma\hat{C}_t + \psi\hat{N}_t \tag{3.17}$$

- Foreign country optimality conditions

$$\sigma^* E_t[\hat{C}^*_{t+1}] - \sigma^* \hat{C}^*_t = \hat{R}^*_t - E_t[\hat{\pi}^*_{t+1}] \tag{3.18}$$

$$\sigma^* E_t[\hat{C}^*_{t+1}] - \sigma^* \hat{C}^*_t = [1 - \beta^*(1-\delta^*)] E_t[\hat{V}^*_{t+1}] \tag{3.19}$$

$$\hat{R}_t - \hat{R}^*_t = E_t[\hat{\pi}_{H,t+1}] - E_t[\hat{\pi}^*_{F,t+1}] + (E_t[\hat{T}_{t+1}] - \hat{T}_t) + \phi \hat{B}^*_{H,t}{}^{1} \tag{3.20}$$

$$\hat{W}^*_t = \sigma^* \hat{C}^*_t + \psi^* \hat{N}^*_t \tag{3.21}$$

3.1.4 Market clearing conditions

$$\hat{Y}_t = \left(\frac{1}{n}\right)\left([1-(1-n)b]\hat{Z}_{H,t} + nb\hat{Z}^*_{H,t}\right) \tag{3.22}$$

$$\hat{Y}^*_t = \left(\frac{1}{1-n}\right)\left((1-n)b\hat{Z}_{F,t} + (1-nb)\hat{Z}^*_{F,t}\right) \tag{3.23}$$

$$\hat{Z}_t = \frac{C^{ss}}{Z^{ss}}\hat{C}_t + \frac{I^{ss}}{Z^{ss}}\hat{I}_t \tag{3.24}$$

$$\text{where} \quad \frac{C^{ss}}{Z^{ss}} = 1 - \frac{\delta}{\frac{1}{\alpha}\left[\frac{1}{\beta} - 1 + \delta\right]\frac{\varepsilon}{\varepsilon-1}}$$

$$\text{and} \quad \frac{I^{ss}}{Z^{ss}} = \frac{\delta}{\frac{1}{\alpha}\left[\frac{1}{\beta} - 1 + \delta\right]\frac{\varepsilon}{\varepsilon-1}}$$

[1] Since the steady state we are log-linearizing around has $B^{*ss}_H = 0$, the log-linearization is with respect to foreign consumption steady state.

$$\hat{Z}_t^* = \frac{C^{*ss}}{Z^{*ss}}\hat{C}_t^* + \frac{I^{*ss}}{Z^{*ss}}\hat{I}_t^* \tag{3.25}$$

$$\text{where} \quad \frac{C^{*ss}}{Z^{*ss}} = 1 - \frac{\delta^*}{\frac{1}{\alpha^*}\left[\frac{1}{\beta^*} - 1 + \delta^*\right]\frac{\varepsilon^*}{\varepsilon^*-1}}$$

$$\text{and} \quad \frac{I^{*ss}}{Z^{*ss}} = \frac{\delta^*}{\frac{1}{\alpha^*}\left[\frac{1}{\beta^*} - 1 + \delta^*\right]\frac{\varepsilon^*}{\varepsilon^*-1}}$$

$$\hat{Y}_t = \hat{A}_{w,t} + \hat{A}_t + \alpha\hat{K}_t + (1-\alpha)\hat{N}_t \tag{3.26}$$

$$\hat{Y}_t^* = \hat{A}_{w,t} + \hat{A}_t^* + \alpha^*\hat{K}_t^* + (1-\alpha^*)\hat{N}_t^* \tag{3.27}$$

3.1.5 Monetary policy rules

$$\hat{R}_t = \omega_R\hat{R}_{t-1} + (1-\omega_R)[\omega_\pi\hat{\pi}_t + \omega_y\hat{Y}_t + \omega_s\Delta\hat{s}_t] + u_t \tag{3.28}$$

$$\hat{R}_t^* = \omega_R^*\hat{R}_{t-1}^* + (1-\omega_R^*)[\omega_\pi^*\hat{\pi}_t^* + \omega_y^*\hat{Y}_t^* - \omega_s^*\Delta\hat{s}_t] + u_t^* \tag{3.29}$$

$$\text{with} \quad \Delta\hat{s}_t = \hat{\pi}_{H,t} - \hat{\pi}_{F,t}^* + (\hat{T}_t - \hat{T}_{t-1})$$

To see how the the expression for the change in exchange rate is derived, use the log-linearized terms of trade equations (2.15) and LOOP (2.13):

$$\hat{s}_t - \hat{s}_{t-1} = \hat{P}_{H,t} - \hat{P}_{F,t}^* - \hat{T}_t^* - (\hat{P}_{H,t-1} - \hat{P}_{F,t-1}^* - \hat{T}_{t-1}^*)$$

$$\Delta\hat{s}_t = \hat{P}_{H,t} - \hat{P}_{H,t-1} - (\hat{P}_{F,t}^* - \hat{P}_{F,t-1}^*) - (\hat{T}_t^* - \hat{T}_{t-1}^*)$$

$$\Delta\hat{s}_t = \hat{\pi}_{H,t} - \hat{\pi}_{F,t}^* + (\hat{T}_t - \hat{T}_{t-1}).$$

3.1.6 Balance of payments equations

$$\beta^*\hat{B}_{H,t}^* - \hat{B}_{H,t-1}^* = \hat{Y}_t^* + nb\hat{T}_t - \hat{Z}_t^* \tag{3.30}$$

$$\hat{B}_{H,t} - \hat{B}_{H,t-1} = -[\hat{B}^*_{H,t} - B^*_{H,t-1}] \tag{3.31}$$

3.1.7 Exogenous shock processes

There are 5 exogenous processes affecting global technology, US (foreign) technology, Mexico (home) technology, US interest rate and Mexico interest rate which are assumed to be AR(1) processes subject to to zero mean i.i.d. errors:

$$\hat{A}_{w,t} = \rho_{Aw}\hat{A}_{t-1} + v_{A_w,t}, \tag{3.32}$$

$$\hat{A}^*_t = \rho_{A^*}\hat{A}^*_{t-1} + v_{A^*,t}, \tag{3.33}$$

$$\hat{A}_t = \rho_A\hat{A}_{t-1} + v_{A,t}, \tag{3.34}$$

$$u^*_t = \rho_{u^*}u^*_{t-1} + v_{u^*,t}, \tag{3.35}$$

$$u_t = \rho_u u_{t-1} + v_{u,t}. \tag{3.36}$$

where $\rho_{Aw}, \rho_{A^*}, \rho_A, \rho_{u^*}, \rho_u \in (0,1)$ are the shock persistence parameters.

3.2 Parametrization

We calibrate the model for a quarterly time period interpreting Mexico as the home country and the US as the foreign country. Table 3.1 summarizes the parameter calibration that was chosen for the model. We assume a discount factor of $\beta = \beta^* = 0.99$, as in Galí & Monacelli (2005), which implies an annual steady state interest rate of around 4.1%. α and α^* were set in 0.33 for the known empirical estimations that indicates that labor earns a share of 66% of the output, assuming constant returns to scale in the production functions, which is very close to benchmark parameter from Aguiar & Gopinath (2007). Price stickiness is set so that the home prices are stickier than foreign prices; in Mexico it is assumed to be $\theta = 0.7$, which implies that a price expected to last 3.33 quarters, which is similar to Schmitt-Grohé & Uribe (2001). On the other side, price stickiness in the US is set at $\theta^* = 0.5$, which implies that a price is expected to last 2 quarters on average. This goes in line with more recent literature estimates for price stickiness in developed and emerging economies (Buffie and Zanna, 2017). To check the robustness of the results, a sensitivity analysis is made by changing the sticky price parameter so that $\theta^* > \theta$.

For the elasticities of substitution of the home and foreign country a similar value is chosen, for Mexico it is $\rho = 0.67$, following McKnight et. al. (2020) and for the US it is $\rho^* = 0.63$ following Lubik and Schorfheide (2005). The parameter of the relative size of the home country was chosen based on the relative populations of both countries, $n = 0.28$, which means that Mexico's population represents 28% of the total population of the two countries. The preferences for imported goods is set to $b = 0.40$ based on the estimates of McKnight et al. (2020) for Mexico. It is assumed that this parameter is shared by both countries and what changes is the home country preferences for imported goods, $(1 - n)b = 0.29$, and the foreign country preferences for home goods, $nb = 0.11$. Following Buffie and Zanna (2017), the home and foreign elasticity of substitution among intermediate goods is set equal, $\epsilon = \epsilon^* = 6$. Also, following the same authors, we choose a similar relative risk aversion coefficient, $\sigma = 2.86$ and $\sigma^* = 3$.

The inverse elasticities of labor supply were based on McKnight et al. (2020) for Mexico and on Buffie and Zanna (2017) for the US. The home and foreign depreciation rates of capital were set both equal to $\delta = \delta^* = 0.05$ following Aguiar and Gopinath (2007). From the same authors we set a very low bond adjustment cost parameter $\phi = 0.001$.

The parameters of the monetary policy rule from Mexico are based on the estimates of Rene Zamarripa (2021) and the estimates for the US rule are taken from Bhattarai et. al. (2021). Both policies satisfy the Taylor principle and give approximately the same importance to output deviations from the steady state. What changes the most is the weight that the monetary authorities give on exchange rate fluctuations, and on the smoothing parameter.

Finally, the US productivity shock persistence parameter is set to 0.81 following Bhattarai et al. (2021) and the global productivity shock persistence is assumed to be the same. For the Mexican productivity persistence parameter we set it to 0.94 following the estimates of Alvarez-Parra (2013). For the interest rate shock persistence parameters, a low value is assumed for both countries to ensure that a positive interest rate shock raises the nominal interest rates. For higher persistence values, through the contemporaneous decrease in the inflation and output following the shock, results in a decrease in the interest rate because of the specification of the Taylor rules under the Taylor principle.

Table 3.1: Baseline Parameter Values

Parameter	Name	Value	Reference
ρ	Home elasticity of subst. between home and imported goods	0.67	McKnight et al. (2020)
ρ^*	Foreign elasticity of subst. between home and imported goods	0.63	Lubik and Schorfheide (2005)
n	Country size	0.28	Own calculation
b	degree of trade openness	0.44	McKnight et al. (2020)
ϵ	Home elasticity of substitution among intermediate goods	6	Buffie and Zanna (2017)
ϵ^*	Foreign elasticity of substitution among intermediate goods	6	Buffie and Zanna (2017)
α	Home elasticity of output for capital	0.33	Common on the literature
α^*	Foreign elasticity of output for capital	0.33	Common on the literature
θ	Home probability of changing the price in a given period	0.7	Common on the literature
θ^*	Foreign probability of changing the price in a given period	0.5	Buffie and Zanna (2017)
σ	Home relative risk aversion coefficient	2.86	Buffie and Zanna (2017)
σ^*	Foreign relative risk aversion coefficient	3	Buffie and Zanna (2017)
ψ	Home inverse of elasticity of labor supply	1.47	McKnight et al. (2020)
ψ^*	Foreign inverse of elasticity of labor supply	2	Buffie and Zanna (2017)
δ	Home depreciation rate of capital	0.05	Aguiar and Gopinath (2007)
δ^*	Foreign depreciation rate of capital	0.05	Aguiar and Gopinath (2007)
ϕ	Bond cost adjustment	0.001	Aguiar and Gopinath (2007)
β	Home discount factor	0.99	Common on the literature
β^*	Foreign discount factor	0.99	Common on the literature
ω_R	Taylor rule: Home interest rate smoothing	0.52	Rene Zamarripa (2021)
ω_R^*	Taylor rule: Foreign interest rate smoothing	0.83	Bhattarai et al. (2020)
ω_π	Taylor rule: Home sensitivity to inflation	2.31	Rene Zamarripa (2021)
ω_π^*	Taylor rule: Foreign sensitivity to inflation	2.4	Bhattarai et al. (2020)
ω_y	Taylor rule: Home sensitivity to output	0.47	Rene Zamarripa (2021)
ω_y^*	Taylor rule: Foreign sensitivity to output	0.55	Bhattarai et al. (2020)
ω_s	Taylor rule: Home sensitivity to exchange rate	0.59	Rene Zamarripa (2021)
ω_s^*	Taylor rule: Foreign sensitivity to exchange rate	0.04	Bhattarai et al. (2020)
ρ_{Aw}	Global productivity shock persistence	0.81	Same as foreign shock
ρ_A	Home productivity shock persistence	0.94	Álvarez-Parra et al. (2013)
ρ_{A^*}	Foreign productivity shock persistence	0.81	Bhattarai et al. (2020)
ρ_u	Home interest rate shock persistence	0.1	Own choice
ρ_u^*	Foreign interest rate shock persistence	0.1	Own choice

Chapter 4

Results

This chapter presents the results obtained from the five shocks in the model, which consists of a global productivity shock, a US (i.e., foreign) productivity shock, a Mexico (i.e., home) productivity shock and home and foreign interest rate shocks from the Mexico and the US. Naturally, the most interesting case are the shocks that originate from the foreign country. Initially, we focus on the spillovers effects under the baseline Taylor rules calibration and then inquire into possible gains from a different specification, specifically without an interest rate response to changes in the nominal exchange rate in Mexico.

Since there is asymmetry in the country size, it is expected that Mexico's shocks don't have a meaningful effect on the US endogenous variables but US shocks should have an important effect on the Mexican variables. Following Bhattarai et. al. (2021), if a foreign expansionary shock causes an improvement (decline) in the home country's product, we say that there are complementary (competitive) spillover effects on the home country.

4.1 Global productivity shock

We explore the effects of a positive, symmetric, global productivity shock in both countries, with the interest in finding if one country benefits the most from it through the trade channel. Figure 4.1 shows the impulse response functions from a 1% increase in global technology. As expected, output in both countries increases initially by the same size as the shock and CPI inflation decreases since firms can produce the same amount of goods with less quantity of labor and capital inputs, so marginal costs reduce and domestic inflation falls through the NK Phillips Curve. Since the prices are less sticky in the US, its domestic inflation decreases a bit more than Mexico's domestic inflation immediately after the shock, therefore the Mexican terms of trade worsens during the first 7 quarters. Because the US exports are relatively cheaper, the current account of Mexico gets into a slight deficit.

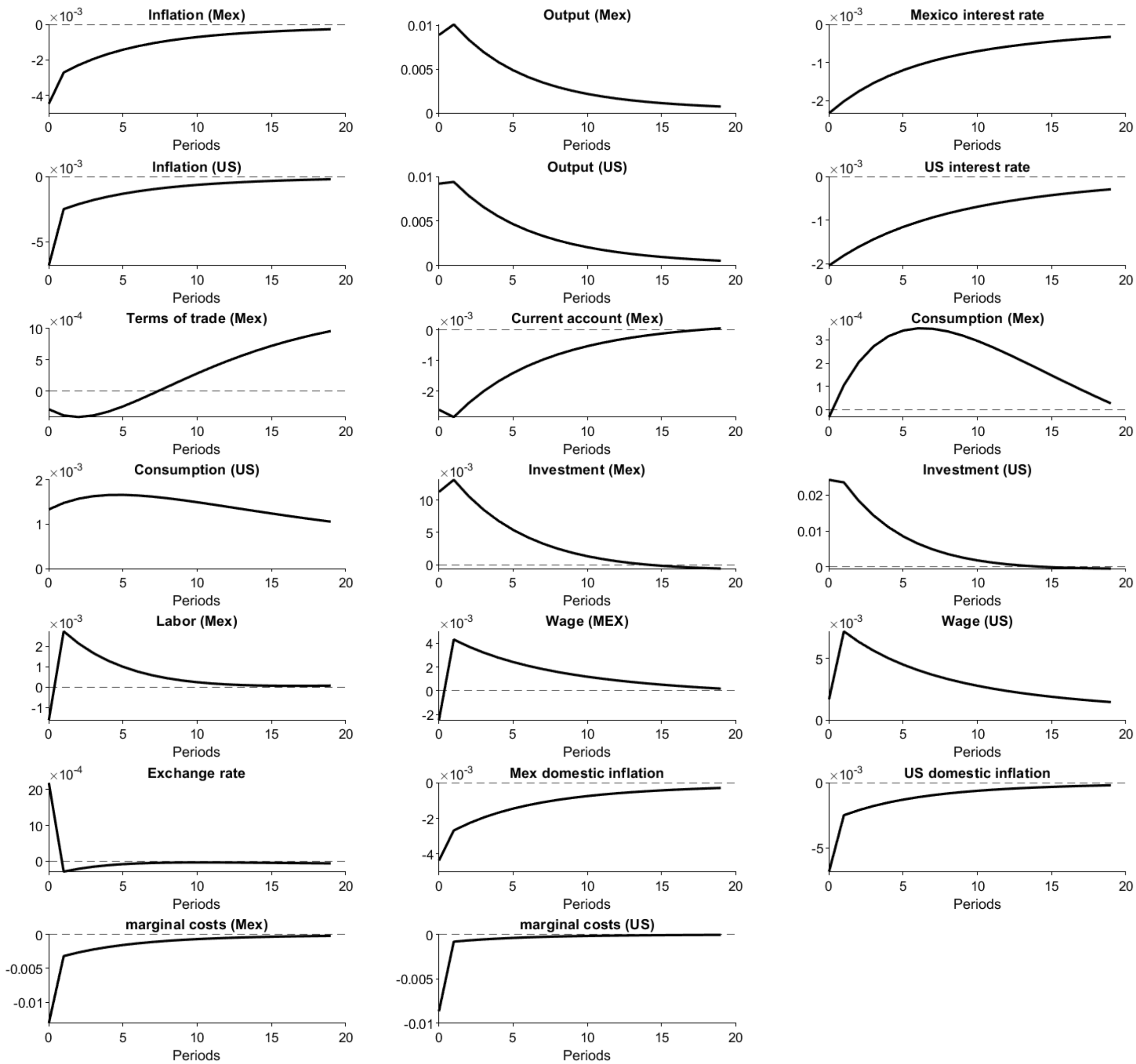
The wages in Mexico decrease while in the US they increase, this could be because the demand for labor in Mexico falls and real marginal costs decrease more in Mexico and converges slower to its steady state, which, at the same time, causes a slower increase in its domestic inflation, which allows the terms of trade to increase after the seventh quarter and onwards, also helped by home bias. The difference in the results lie on the trade channel and may be due to the difference in the degree of price stickiness (which is indeed what we find in the sensitivity analysis, see figure 4.9). Other reasons this can happen (which are also examined in the sensitivity analysis below) are because of a different market size or because of different parameter values of the home and foreign elasticity of substitution between home and imported goods. Also, the consumption in both countries increase, but in Mexico it takes time, this could be because of the initial decrease in wages.

The nominal interest rate decreases similarly in both countries given the relative importance of deviations in the inflation rate compared to output deviations from the steady state in the Taylor rules.

4.2 US productivity shock

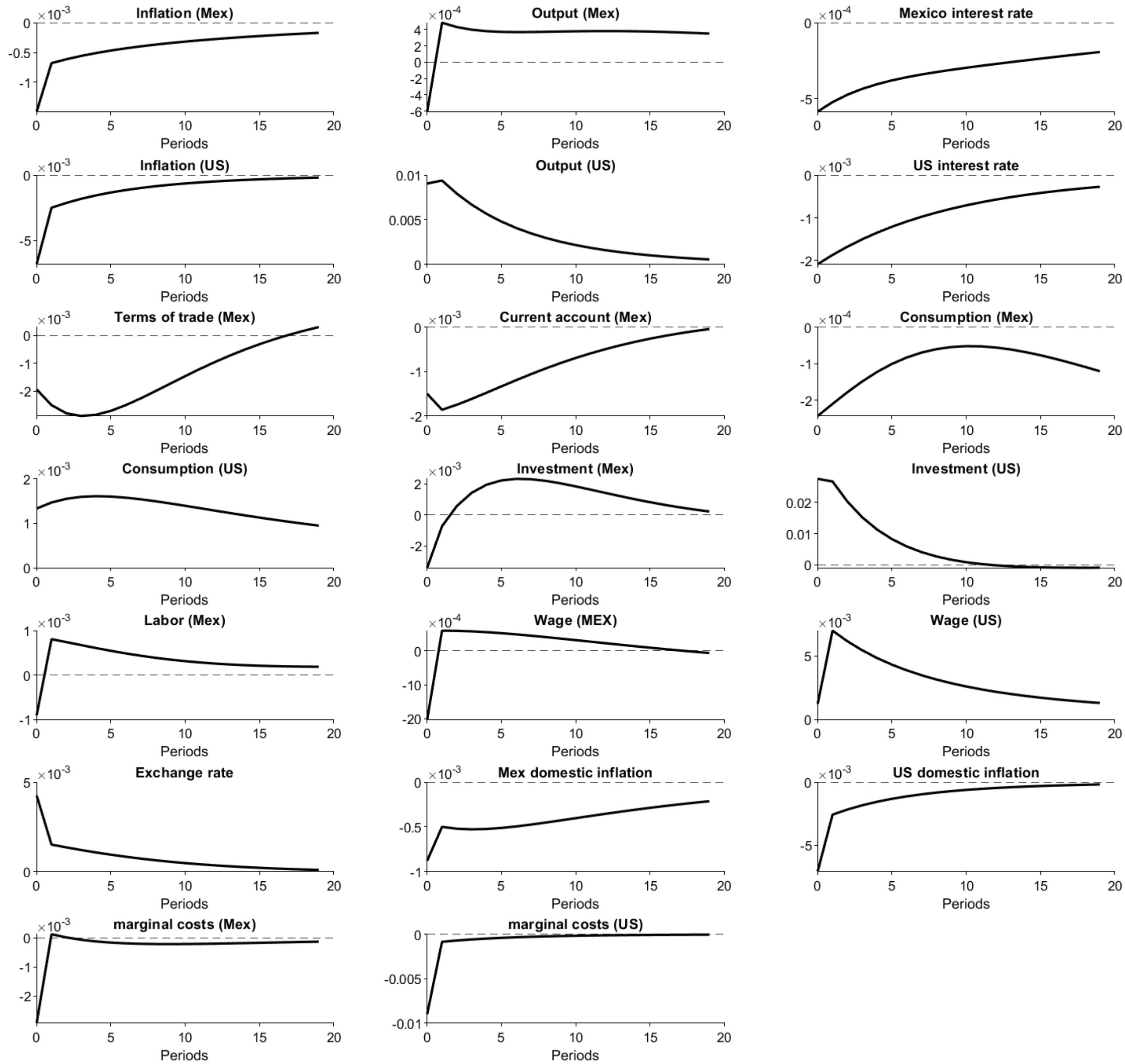
Figure 4.2 shows the impact of a positive 1% US productivity shock. The output in the US increases and CPI inflation decreases since firms can produce the same amount of goods with less quantity of labor and capital, so real marginal costs reduce and domestic inflation falls through the NK Phillips Curve. The decrease in US domestic inflation deteriorates the terms of trade and causes a fall in Mexico inflation by cheaper imported goods, this decreases the current account since imports are now cheaper relative to exports. Mexican output decreases initially but rapidly increases above its steady state and converges very slowly, probably helped by the US demand. Given the evolution of output and inflation, the nominal interest rate falls, although less than the US. Finally, in spite of the increase in US consumption and investment (i.e. aggregate demand) and the fall in Mexico's consumption and moderate rise in investment, the current account gets in a deficit helped by the terms of trade and the increase in US output, which counteract the first effects.

Figure 4.1: Impulse responses under a positive 1% global productivity shock.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.2: Impulse responses under a positive 1% productivity shock originating from the US



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

The results differ greatly from the global shock due to the fact that the domestic US inflation falls a lot more following the shock, which deteriorates the terms of trade and worsens the current account since imported products are relatively cheaper. Since this is an asymmetric shock, the exchange rate is expected to fluctuate more and, in this case, it depreciates and influences positively the Mexican interest rate. In this type of shock, the results are expected to be generally robust to changes in the price stickiness and substitution between home and imported goods parameters, since those changes can't overcome the difference in domestic inflation of both countries, but they could influence importantly the wages and investment in the US en Mexico through the mechanism explained earlier.

Given the evolution of the endogenous variables in the home country after a purely external productivity shock, there is no clear sign of the spillover effects since output decreases initially in Mexico but increases later. These results differ from the DSGE model of Bhattarai et al. (2021), since the IRF shows a clear competitive effect from a US productivity shock.[1]

4.3 Mexico productivity shock

Even though the interests of this thesis are the spillover effects, it is important to analyse if the home shocks affect the home endogenous variables through second order propagation effects. This could happen if the US variables also suffer from considerable spillover effects.

Figure 4.3 shows the impact of a 1% increase in technology in Mexico. Mexican output increases by more than 1% helped by the improvement on the terms of trade,

[1]Although the spillovers are competitive in the DSGE results, they find that using a VAR methodology the spillovers are actually complementary.

which increases because the Mexican domestic inflation falls more relative to the US. CPI Inflation also falls by the mechanism explained earlier and US CPI inflation increases only marginally. Although the current account gets in a deficit, because foreign capital flows into Mexico to finance investment, it is quickly recovered. US output starts above its steady state and rapidly decreases and evolves to be below after a few quarters, but the impact is very small. Since the foreign variables barely respond to home changes, there are not considerable second order effects from the home shocks. This is an expected result since the asymmetry of the countries sizes gives more importance to the US economy, as should be.

There are significant differences between the US and Mexico productivity shocks: in both cases the current account enters a deficit, but the terms of trade move in opposite directions. This shock has a small effect on US output and there is no clear sign if a productivity shock has complementary or competitive effects from the US to Mexico, which are similar to the results of Bhattarai from the same shock.

4.4 US interest rate shock

We now focus on the effects of a positive (i.e. contractionary) US interest rate shock. It is first noted that, depending on the Taylor rule specification, a positive interest rate shock may increase the nominal interest rate by less than the size of the shock. It can even be the case that "*...if the persistence of the monetary shock is sufficiently high, the nominal rate will decline in response to a rise in the shock*" (Galí, 2015, p 67).

A shock of this type can have different interacting mechanisms for the other country's economy. For one side, a decrease in the other country domestic inflation and the increase in the foreign interest rate improves the terms of trade of the home country, while the reduction in the imported goods inflation causes a lower home interest rate, benefiting the home country. But for the other side the decrease in output decreases the demand of imported goods, so there is not a clear answer if the spillover effects are positive or negative.

Figure 4.4 shows the impulse response functions from a 1% increase in the interest rate shock term. As expected, the US output and CPI inflation fall since the household reduces its current consumption and investment and since wage and rental price of capital fall, so does marginal costs. This results in a reduced Mexican output and a fall in imported goods inflation. One important thing is the fact that Mexico's nominal interest rate rises more than the US even if the shock origin was foreign to avoid an unwanted exchange rate depreciation, which causes a rapid deterioration of the terms of trade even if it increases initially. The current account increases only to converge rapidly to its steady state. It is important to note that Mexico's output falls considerably, almost mimicking the US output evolution and returns quickly to the steady state, while inflation falls only slightly. This suggests there are very strong negative spillover effects caused by a monetary shock and explains a co-movement between the Mexican and US nominal interest rate.

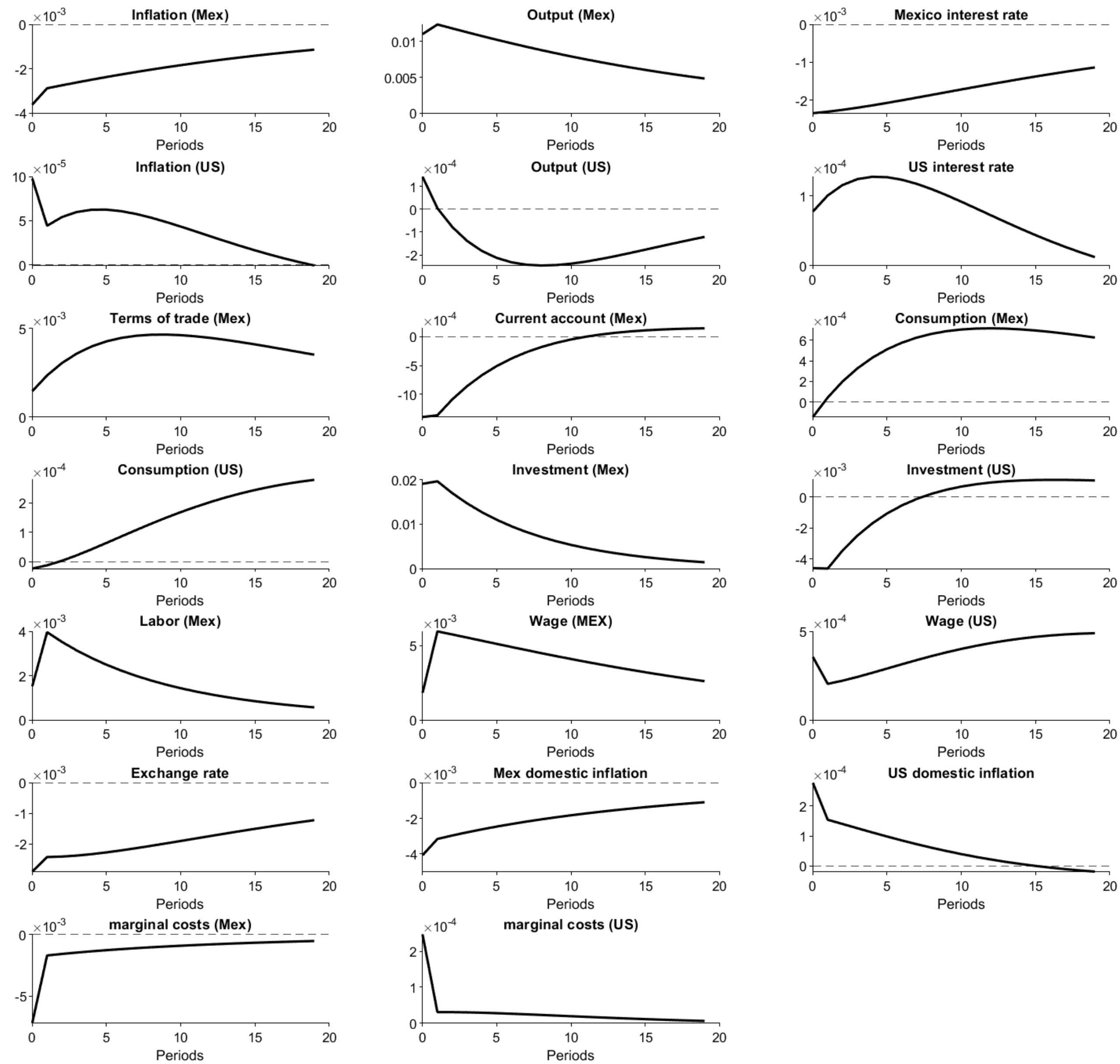
Changes in the Calvo pricing parameter may change the results importantly, since a higher degree in stickiness in the US and a lower degree in Mexico will favour the Mexican terms of trade following the shock. Output in the US may decrease even more as prices can't adjust as fast, but the spillover effects are ambiguous.

4.5 Mexico interest rate shock

We now move to analyse a 1% increase in Mexico's interest rate shock term (a contractionary shock). As the impulse response functions from figure 4.5 show, Mexico's output decreases significantly for a brief period before returning to its steady state and inflation decreases slightly. One notable thing is that the Mexican monetary authority, in an effort to avoid an unwanted appreciation, decreases the interest rate importantly, so much in fact that this reaction causes that the domestic inflation in the US to be lower than in Mexico, which explains the worsen in terms of trade. Also, the initial decrease in the the interest rate so capital flows don't flow as much from the US to Mexico. This causes that, at least initially, the current account is above its steady state value, but it gets in a deficit as soon as the Mexico interest rate increases significantly.

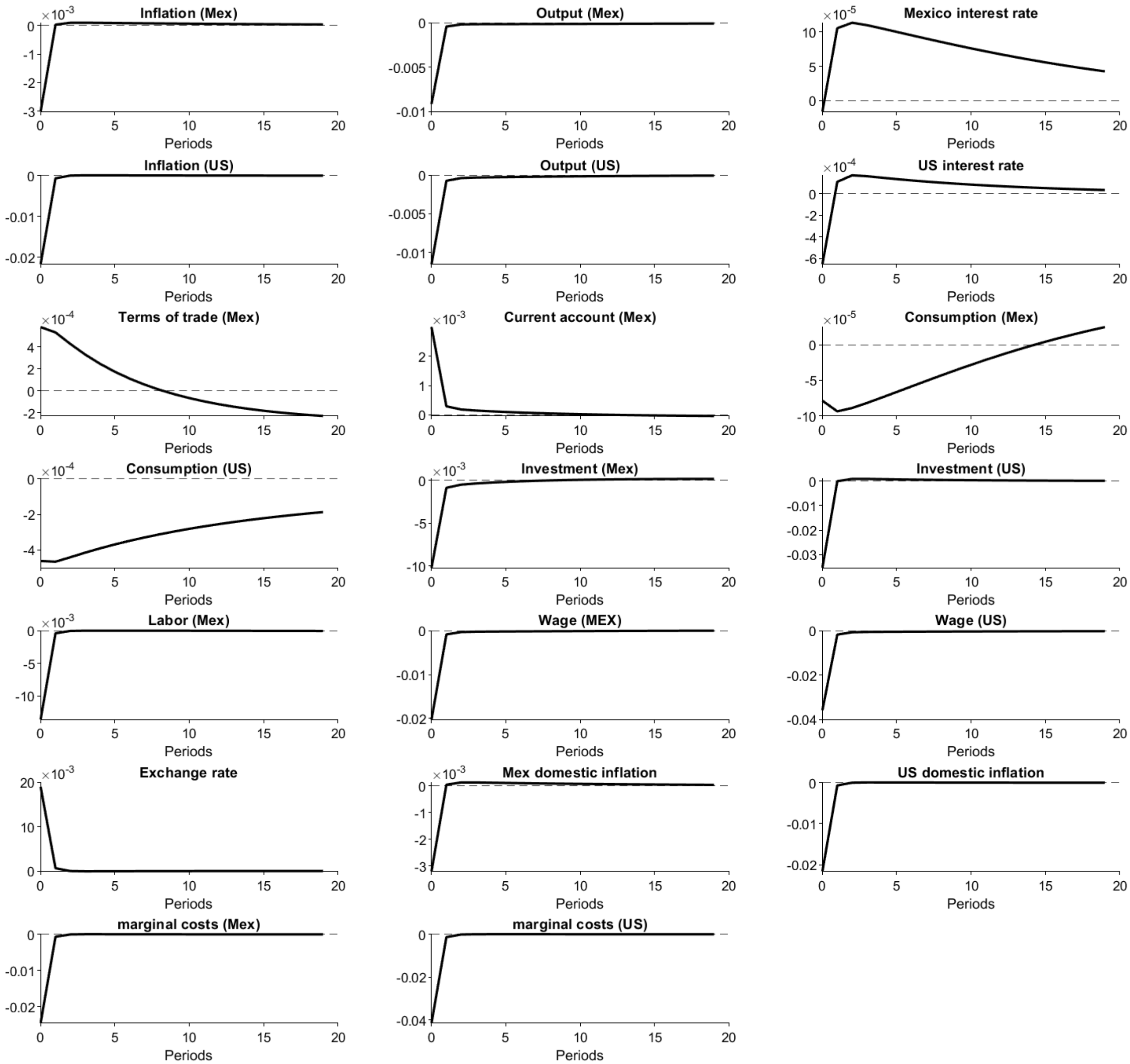
These results are similar to Bhattarai et al. (2021). We find that the interest rate shocks have competitive spillover effects, since an increase in interest rates causes that the terms of trade favors the country with the lower domestic inflation. We don't find a clear sign of spillover effects with the US and Mexico productivity shocks, at least with the Taylor rule specifications that we are using.

Figure 4.3: Impulse responses under a positive 1% productivity shock originating from Mexico. Vertical axes: % deviation from the steady state. Horizontal axes: quarters



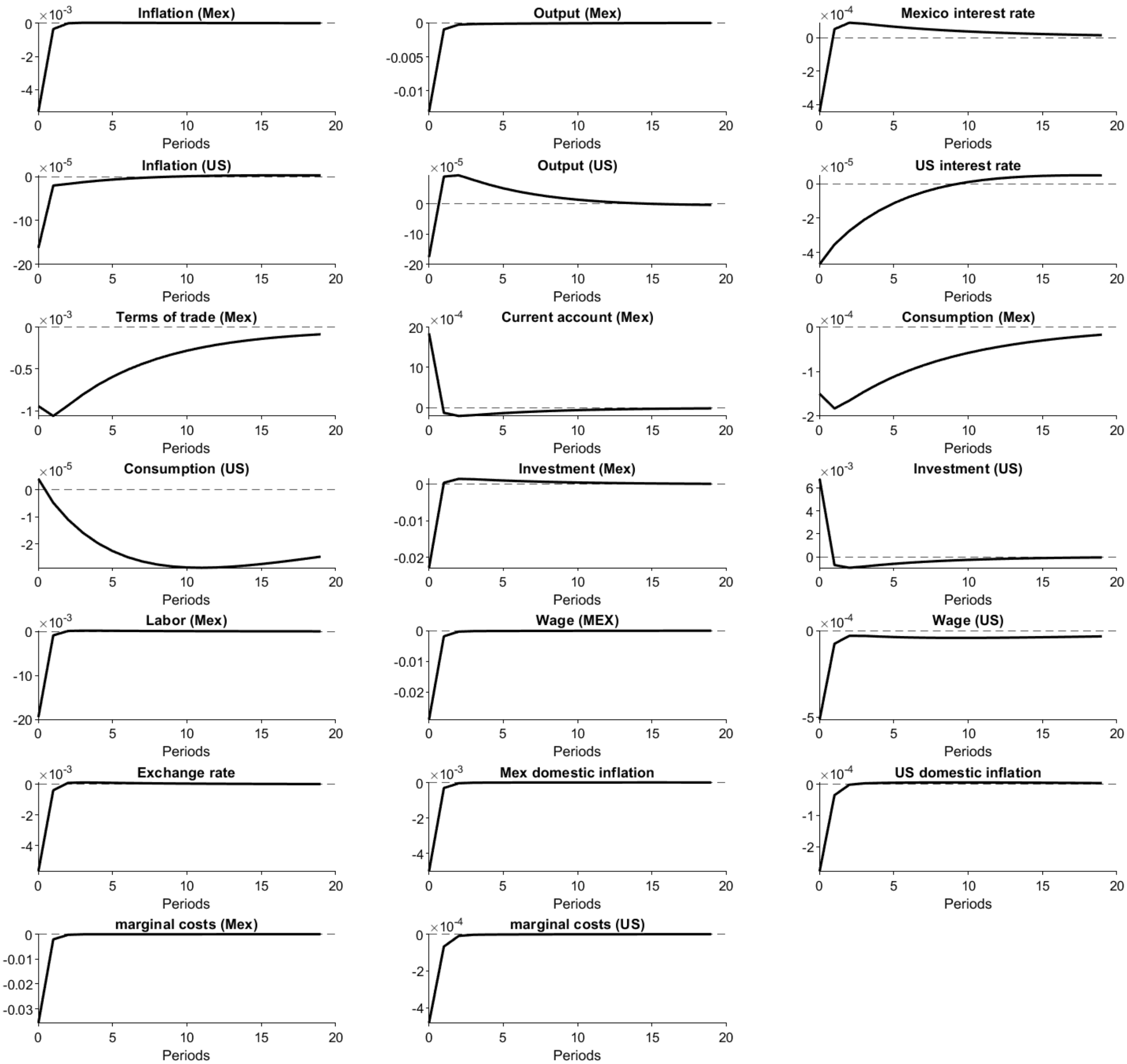
Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.4: Impulse responses under a contractionary 1% interest rate shock originating from the US.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.5: Impulse responses under a contractionary 1% interest rate shock originating from Mexico.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

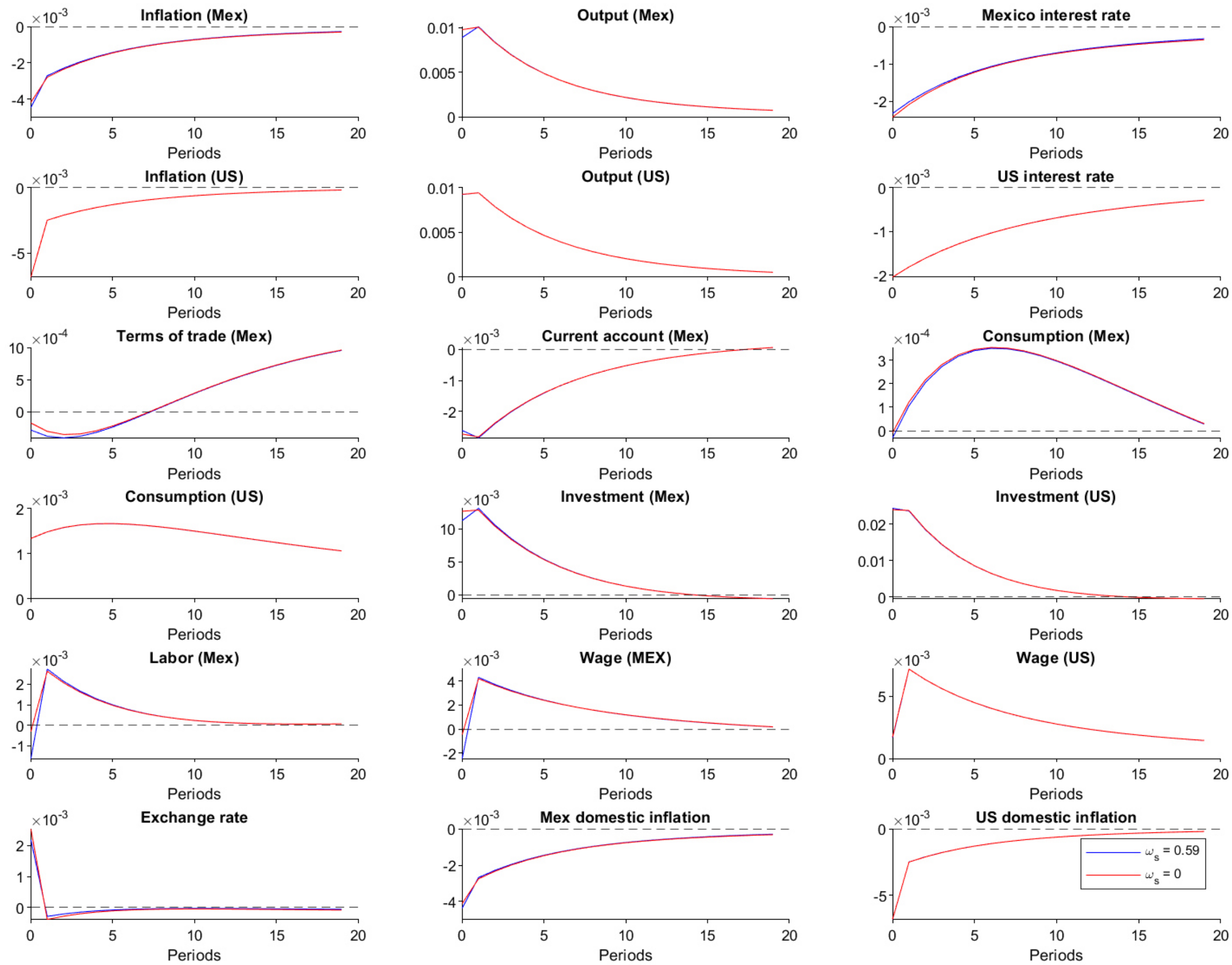
4.6 What if the Mexican monetary authority doesn't target the changes in the exchange rate?

The previous results were based on the empirically estimated parameters for the preferences of Banco de México expressed through the Taylor rule. We now investigate what happens if the central bank doesn't target the nominal exchange rate changes, $\omega_s = 0$, while maintaining the remaining parameters as before. Figure 4.6 shows the impulse responses after a positive 1% global productivity shock. It is easy to see that the parameter change didn't make a significant difference whatsoever in the responses of the endogenous variables from neither country. Because the shock is symmetric, an asymmetric policy response has little effect on the trade channel as the exchange rate shouldn't move enough to get any differences in the response of the nominal exchange rate in both scenarios.

A case where there are obvious differences from the change in the parameter is figure 4.8, which shows the impulse responses from a 1% positive US productivity shock. There aren't any discernible difference in the US endogenous variables, but the response of Mexican variables are vastly different. Inflation now decreases significantly less and output increases more derived from the foreign shock since the nominal interest rate doesn't fall as much because of the exchange rate. This simple change causes an improvement by taking advantage of the model mechanics, but since the current account and the terms of trade don't suffer significant changes, this improvement occurs through channels different from trade, specifically, it is by avoiding an excessive initial response to a potential currency appreciation.

Finally, we analyse the impulse responses to a external 1% contractionary interest rate shock. The obvious changes are that home output avoids the deep decline under

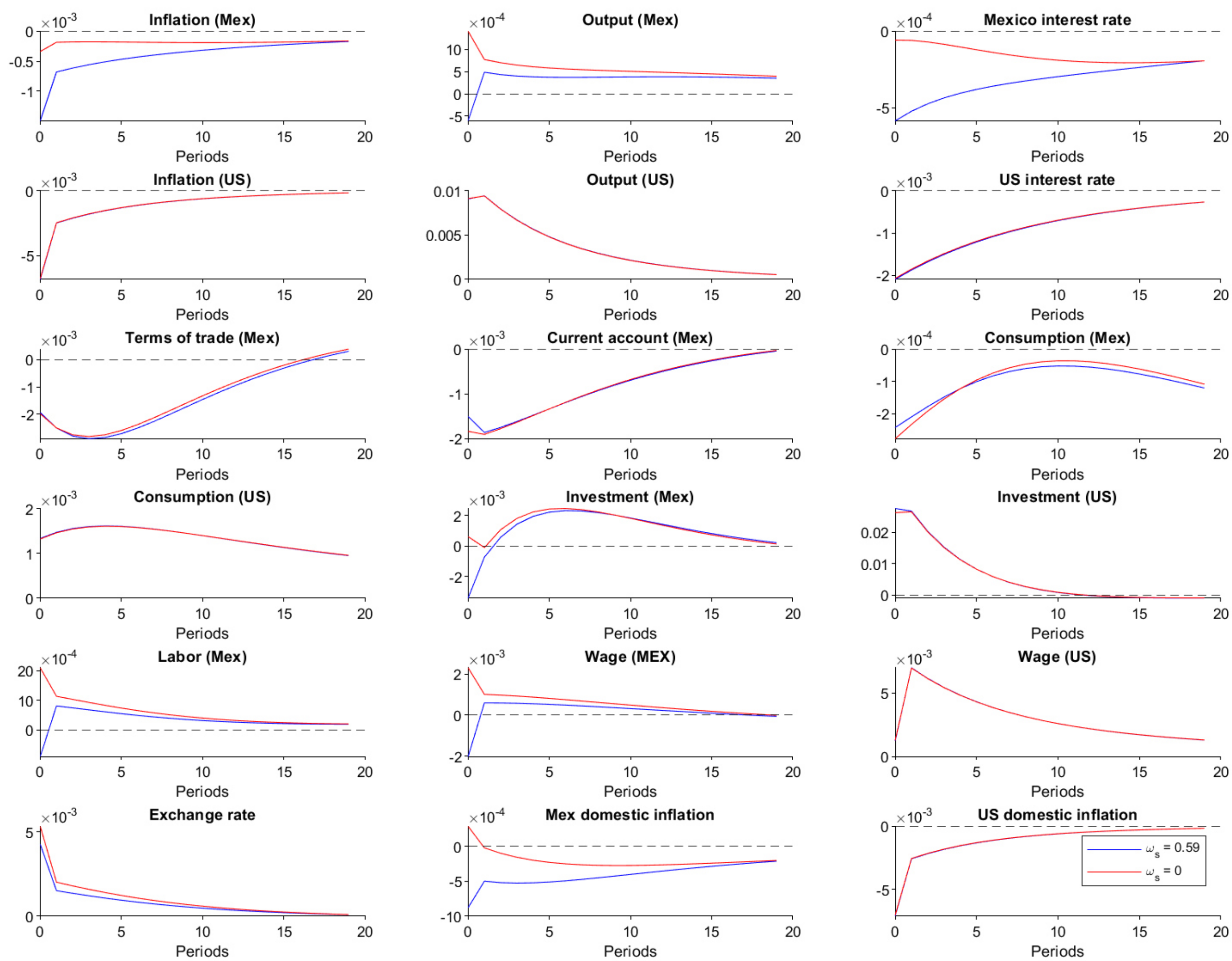
Figure 4.6: Impulse responses under a positive 1% global productivity shock with $\omega_s = 0$.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

the baseline calibration helped by a lower increase in the nominal interest rate and a considerable improvement on the terms of trade. In this case the trade channel plays a very important role in changing the spillovers from the US shock.

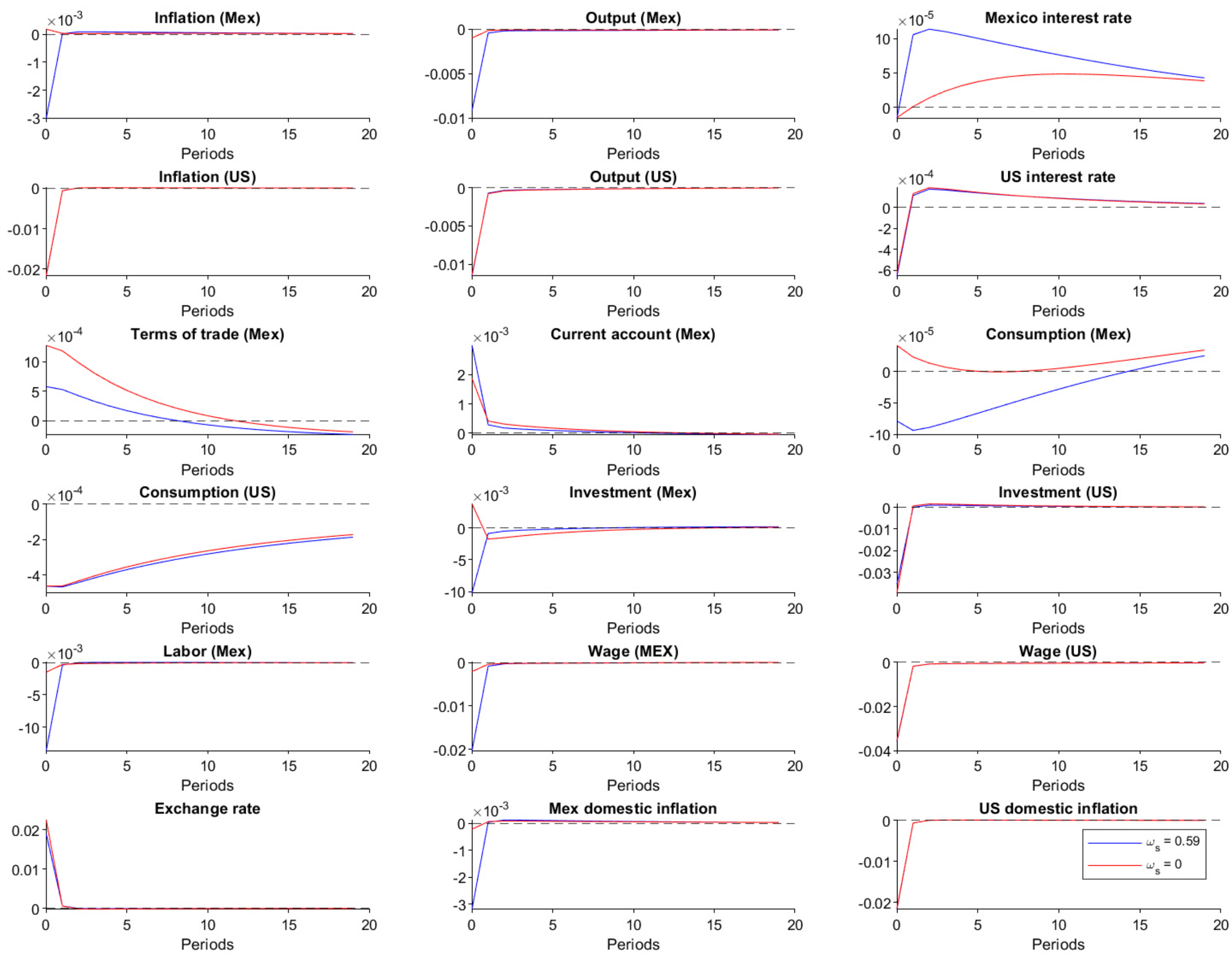
Figure 4.7: Impulse responses under a positive 1% productivity shock originating in the US with $\omega_s = 0$.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Here, we find that not targeting exchange rate fluctuations is beneficial for Mexico. The spillover effects from a positive US technology shock now are complementary, since an increase in US product is now associated with a clear increase in the Mexican output. For the case of US interest rate shock, not targeting the exchange rate shields the Mexican economy to an excessive interest rate increase, therefore diminishing the negative spillover effects that this type of shock had on the previous analysis.

Figure 4.8: Impulse responses under a contractionary 1% interest rate shock originating in the US with $\omega_s = 0$.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

4.7 Sensitivity analysis

We explore if the results are robust to a change in some key parameters and the previous results hold to an alternative calibration from the baseline. In particular, we investigate if the results are robust to a change in the degree of price stickiness, to changes in the elasticity of substitution of domestic and imported goods and on the relative size of the two countries.

4.7.1 Price stickiness

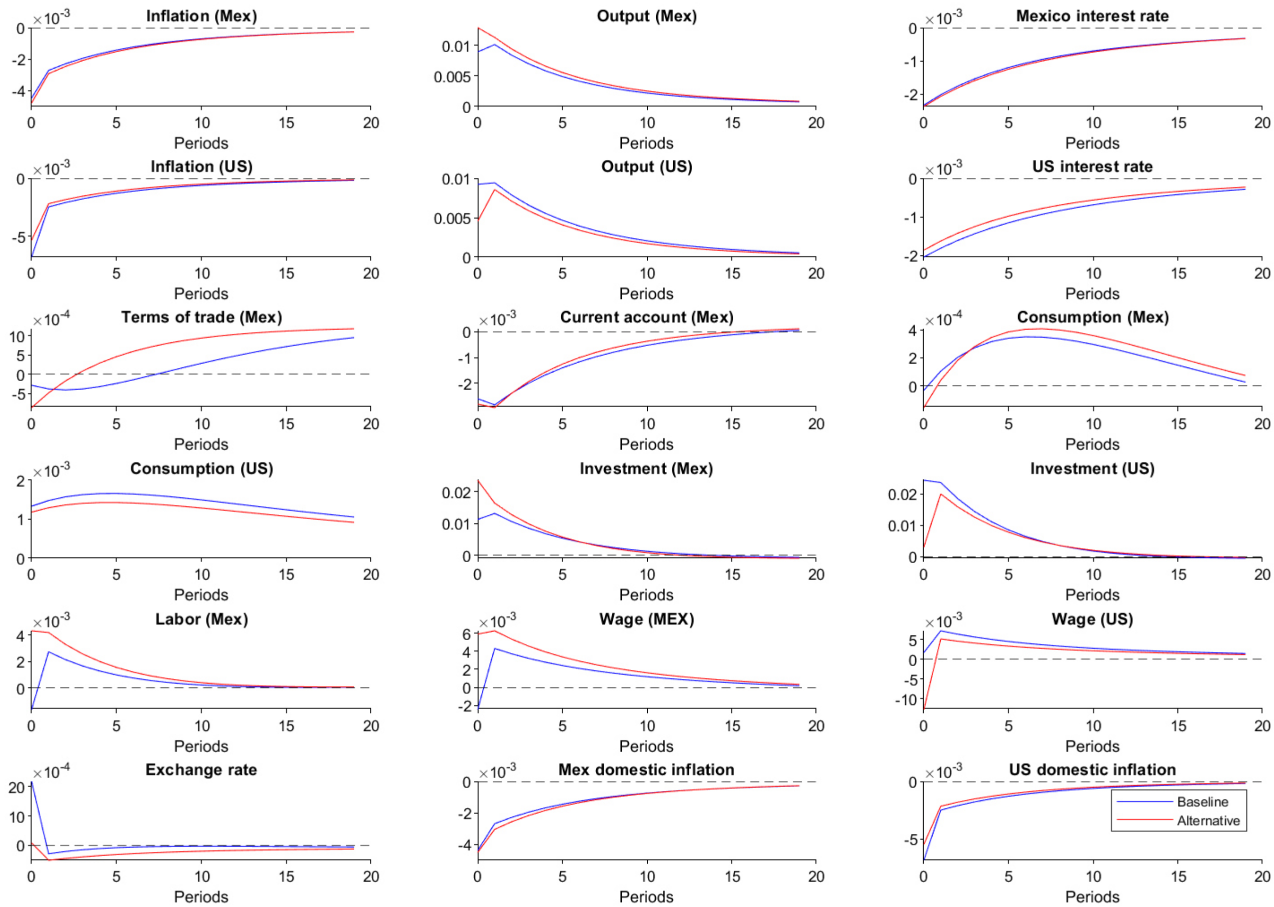
We change the Calvo parameter so that the foreign economy is now more sticky than the home country, $\theta = 0.5$ and $\theta^* = 0.7$. We keep the rest of the baseline parameter values the same as in table 3.1.

It can be seen from figure 4.9 that the results from a global positive productivity shock are generally not robust to changes in the sticky price parameters.The terms of trade falls more immediately after the shock and then increases faster than in the original parametrization. This change also increases the wage in Mexico and decreases the wages in the US. This fact gives us an indication that the transmission mechanism explained before about the global productivity shock makes sense and that more flexible prices are beneficial in a symmetric global productivity shock, allowing the country to take advantage of the trade channel by improving its terms if trade relative to its trading partner. Other notable differences are the exchange rate, which fluctuates a lot less, and investment, which increases in Mexico and decreases in the US under these parameters. This proves that the evolution of these variables does depend a lot on the different degrees of price stickiness, benefiting the one with more flexible prices.

From figure 4.10 we can infer that while more flexible the prices, more complementary are the spillover effects from positive technology external shocks. Now, the home product unambiguously increase. Also, there are differences in consumption, home and foreign wage and labor.

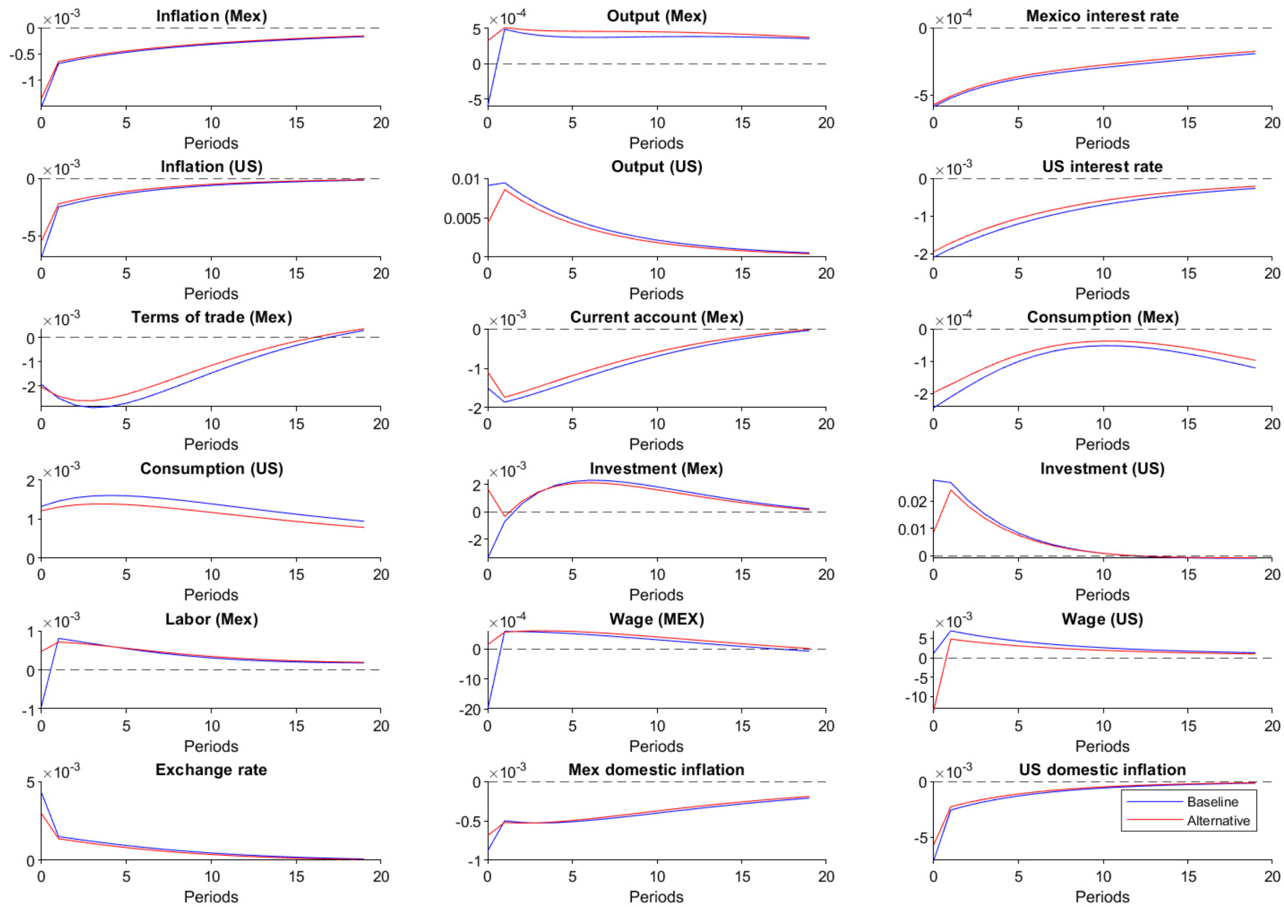
Lastly, we can see from figure 4.11 that the results are not robust to the change in parameters following an external contractionary interest rate shock. There are serious differences in all the endogenous variables from both countries. Output in the US suffers a bigger fall when prices are stickier and Mexico benefits from more flexible prices. The terms of trade improve and the current account increases. There are very different responses from consumption in both countries since consumption in Mexico increases and US decreases more, even if output decreases in the two economies.

Figure 4.9: Impulse responses under a positive 1% global productivity shock with alternative parameters.



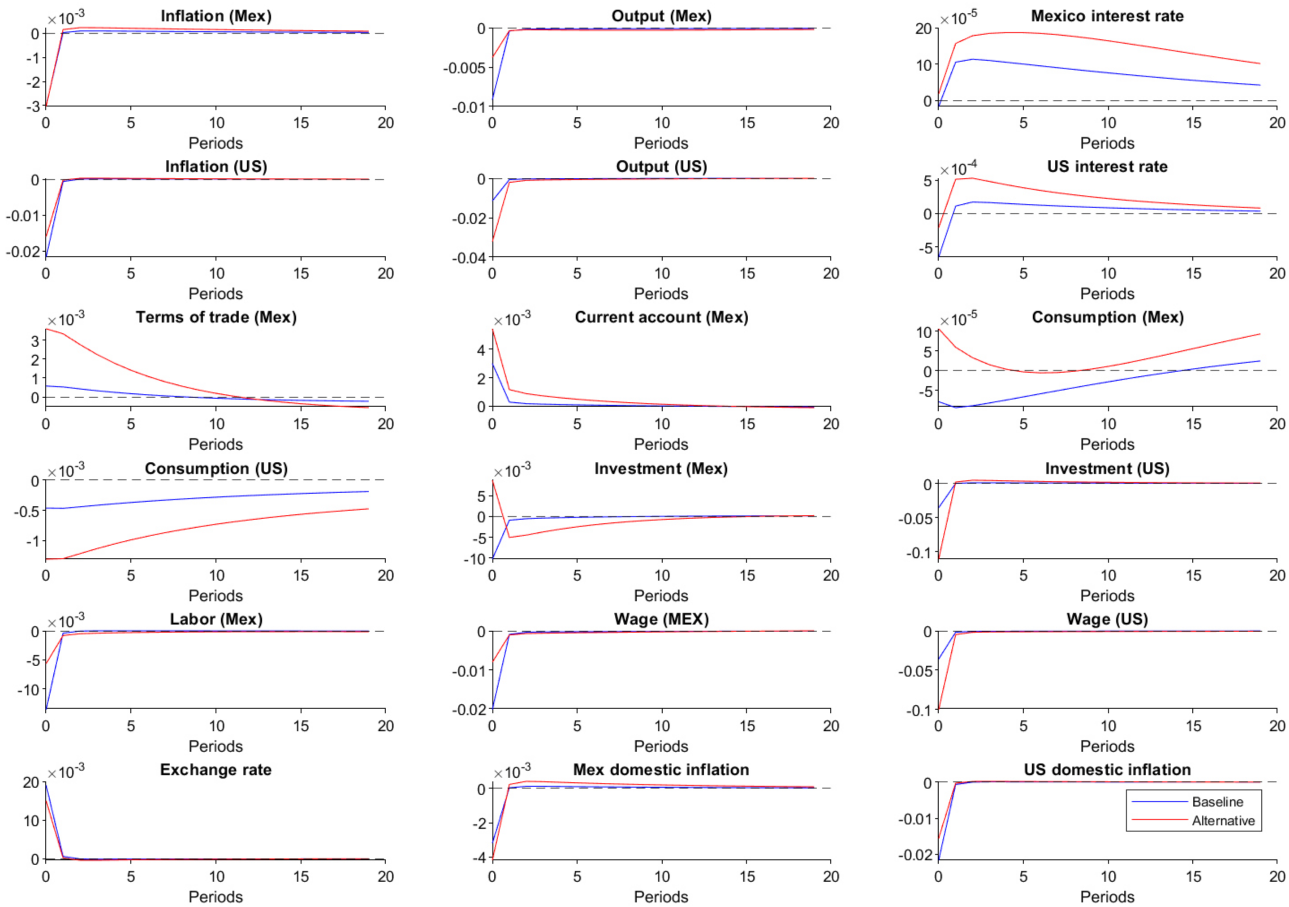
Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.10: Impulse responses under a positive 1% productivity shock originating in the US with alternative parameters.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.11: Impulse responses under a contractionary 1% interest rate shock originating in the US with alternative parameters.



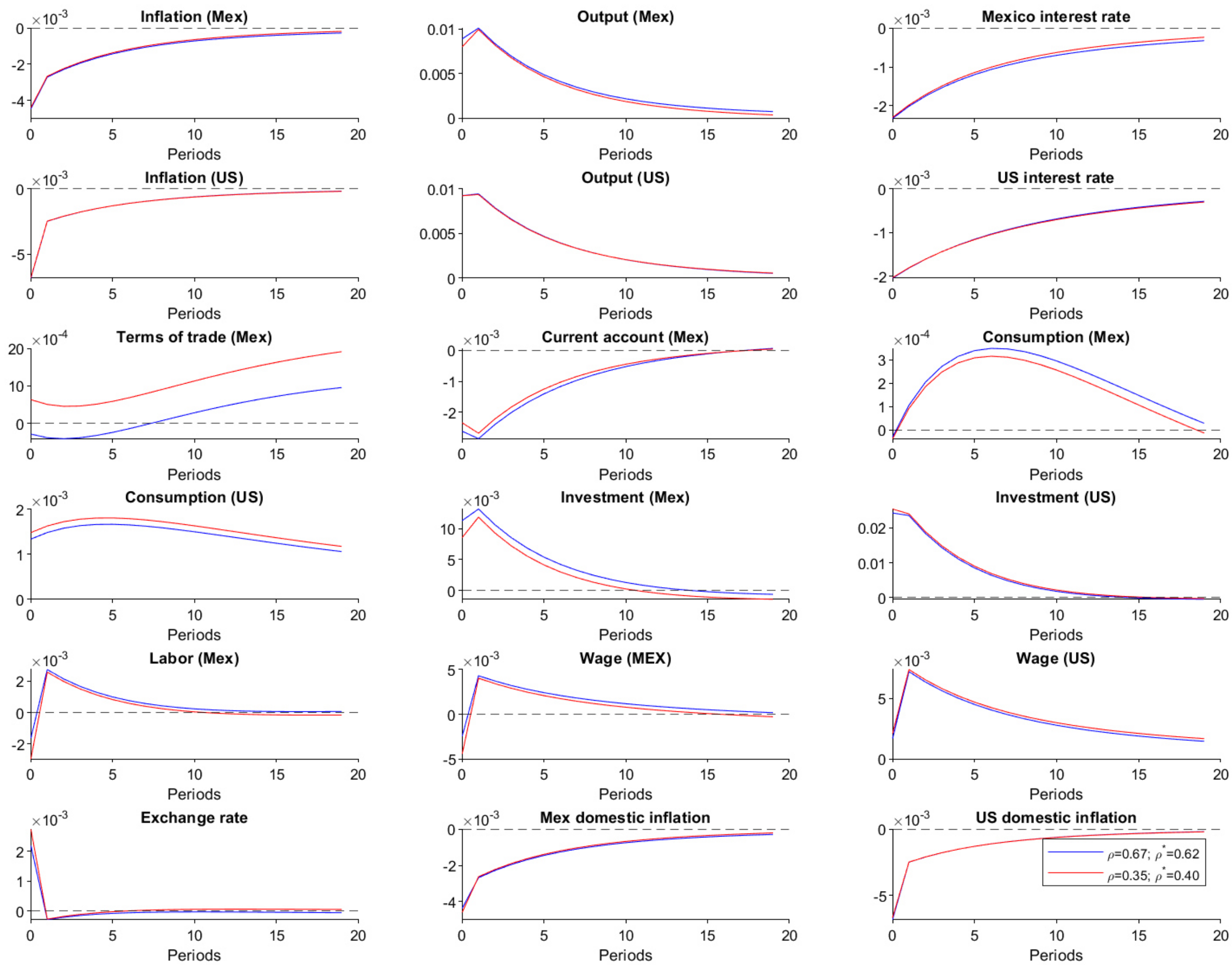
Vertical axes: % deviation from the steady state. Horizontal axes: quarters

4.7.2 Elasticity of substitution between domestic and imported goods

We now move to analyse a change from the elasticity of substitution between domestic and imported goods. We reduce the parameters from both countries following the evidence found by Lubik and Schorfheide (2005) that suggests a lower value in contrast to some literature. However, we choose the values to invert the relations so that the home parameter is now lower than the foreign, $\rho = 0.35$ and $\rho^* = 0.40$.

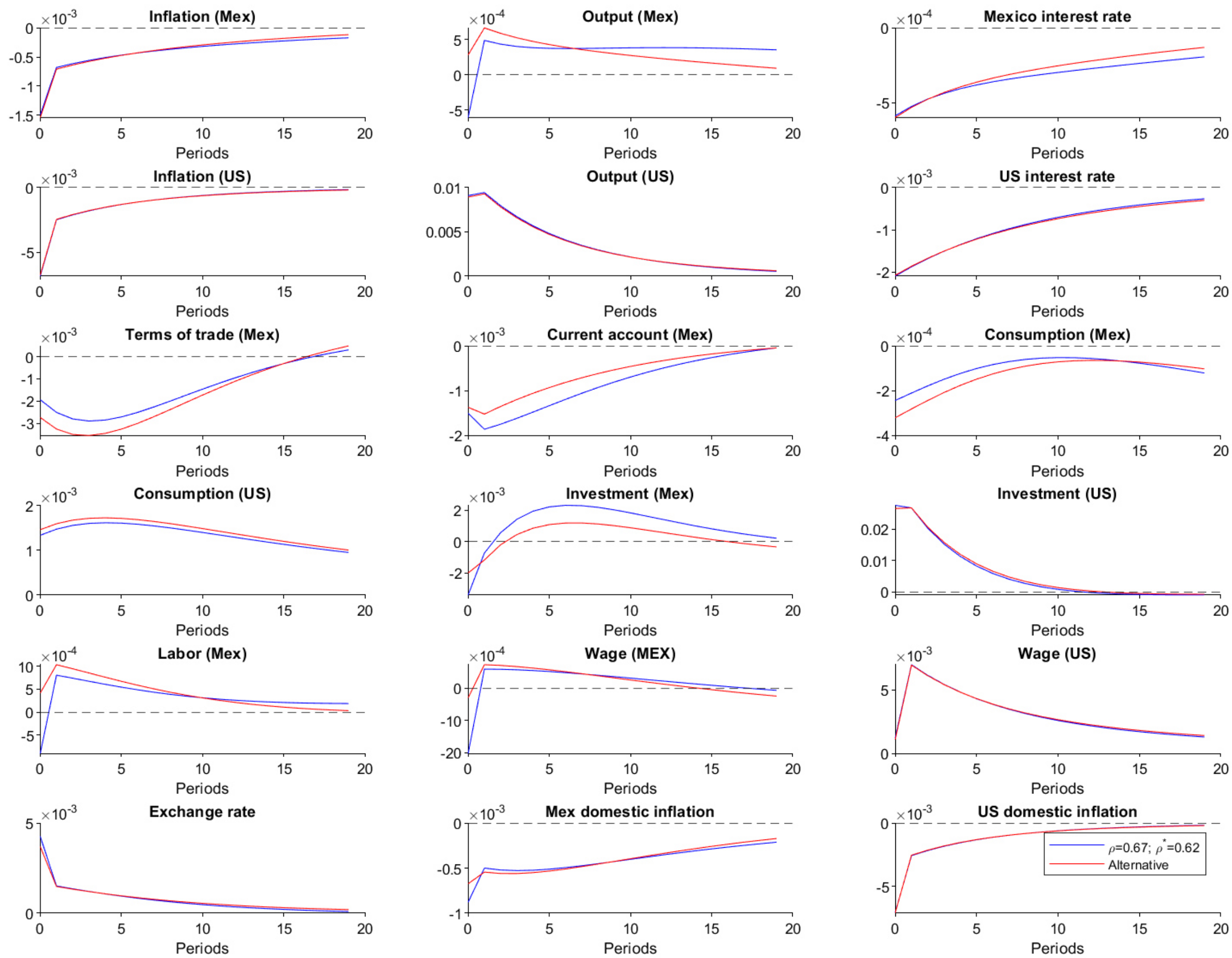
As can be seen in the figures 4.12, 4.13 and 4.14, the results are robust to changes in these parameters. The variables that suffer more changes are the the current account and investment. This is because a decrease in the elasticity of substitution between domestic and imported goods implies that consumers are less responsive to changes in the relative prices of these goods. Nevertheless, we don't find significant differences from the change in the parameters.

Figure 4.12: Impulse responses under a positive 1% global productivity shock with alternative parameters.



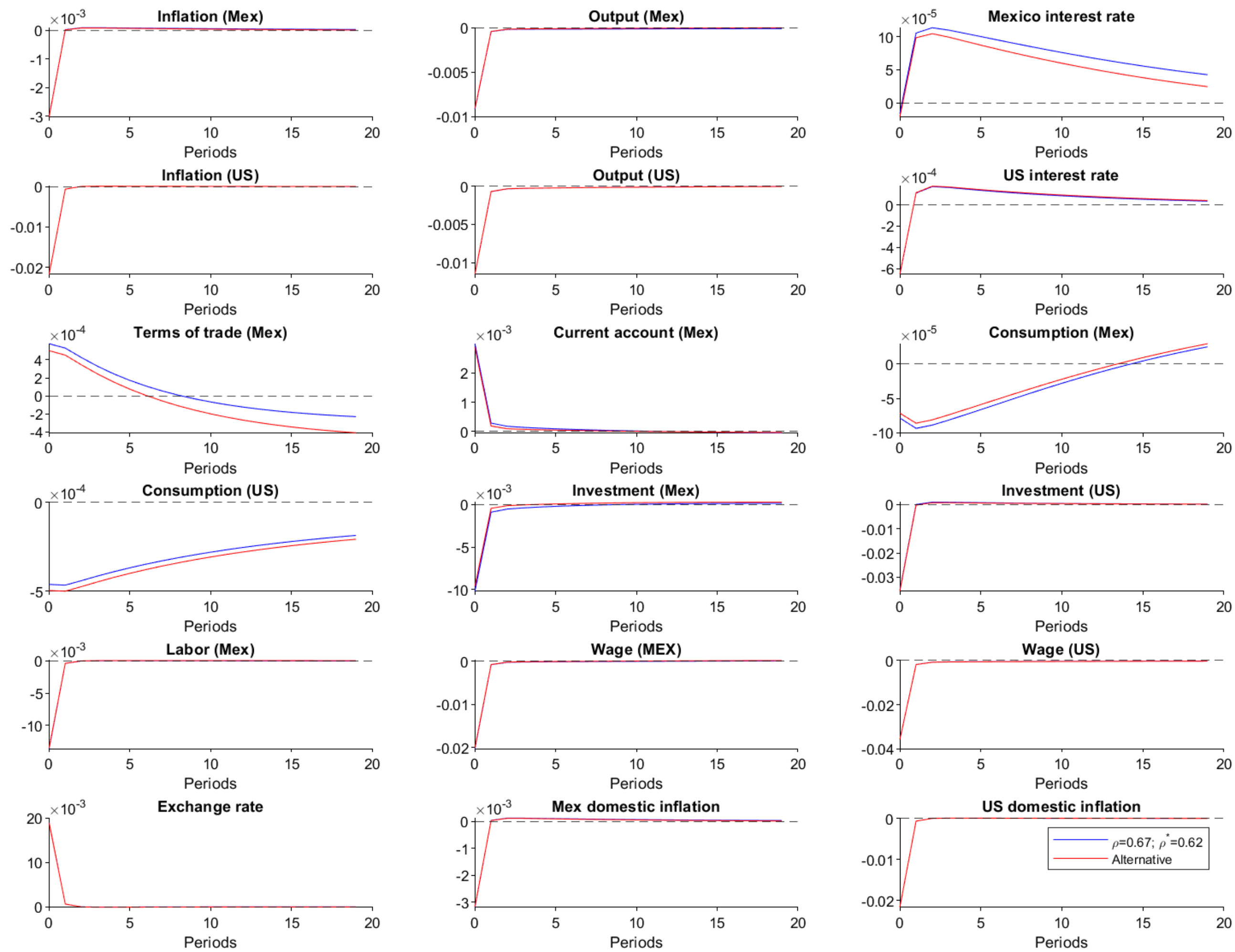
Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.13: Impulse responses under a positive 1% productivity shock originating in the US with alternative parameters.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.14: Impulse responses under a contractionary 1% interest rate shock originating in the US with alternative parameters.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

4.7.3 Relative country size

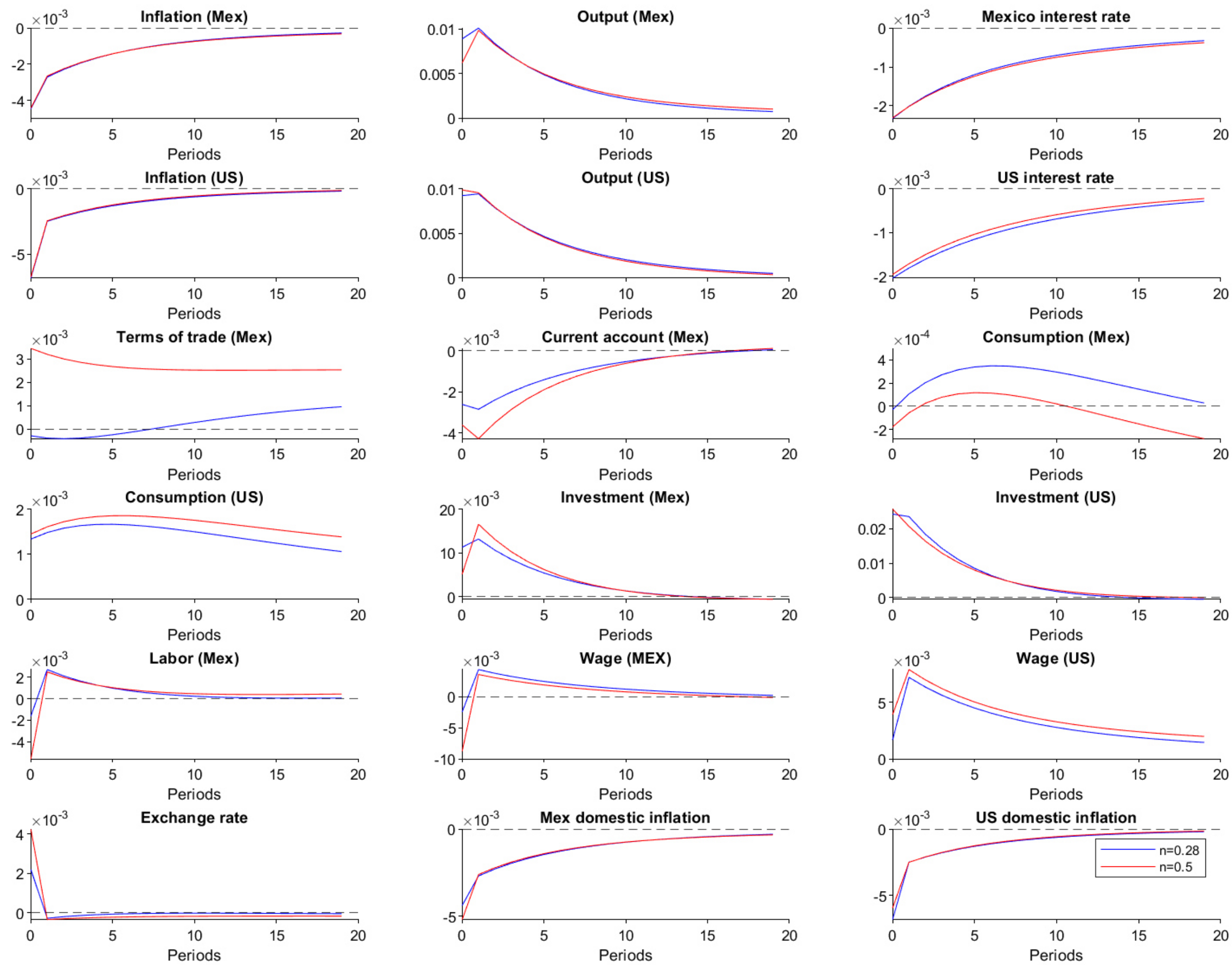
We now move to analyse what happens if we set the parameter $n = 0.5$, i.e., both countries are the same size. Large differences are expected since now there could be important spillover effects from Mexico to the US, which, at the same time, could cause second order effects that reverberate through both countries endogenous variables. It is important to note that this changes the home country preferences for imported goods, $(1-n)b = 0.2$, and the foreign country preferences for home goods, $nb = 0.2$, so this change imply the same type of preferences in this sense.

As we see in the figures 4.15 to 4.19, the global technology shock has different responses, given it it is a symmetric shock, with respect to the baseline parameter values from table 3.1. Consumption falls considerably in Mexico and terms of trade increases, the current account enters a deficit, although less than before.

The results from a US productivity shock also changes in some degree, the terms of trade now deteriorate and consumption increases a lot in Mexico. Mexican output now decreases much less than before, indicating that the economy is less dependant on what happens in the other country. The rest variables remain pretty similar to the benchmark values. For the interest rate shock in the US there is not much to say, the results don't change in many ways.

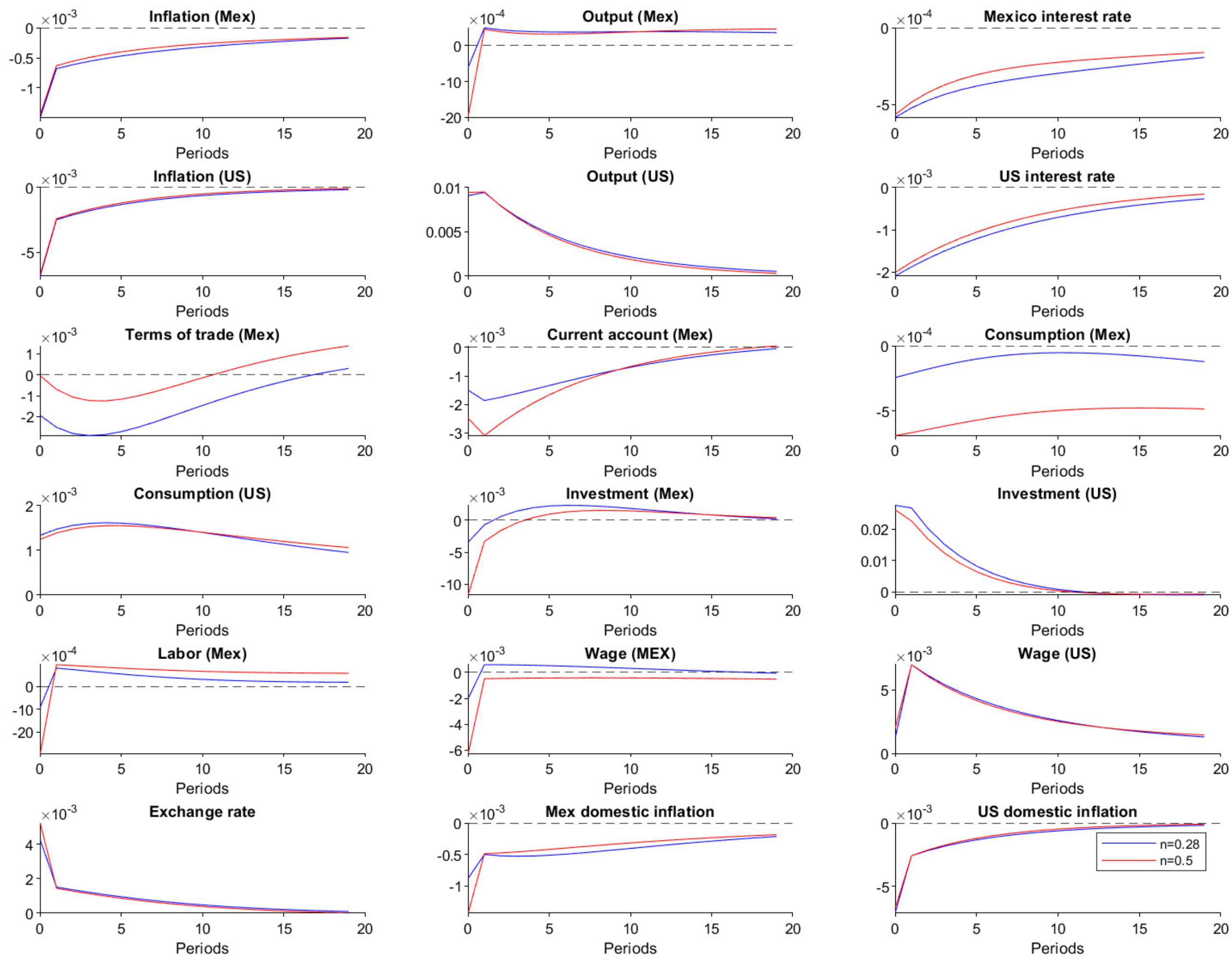
In the case of technology shock in Mexico, there are a lot of differences deriving from a bigger market size in Mexico. US CPI inflation turns negative after the fourth quarter, US output decreases and it's not benefited from an increase in global demand. We find the surprising result that there may be slight competitive spillovers derived from an increase in Mexican productivity.

Figure 4.15: Impulse responses under a positive 1% global productivity shock with alternative parameters.



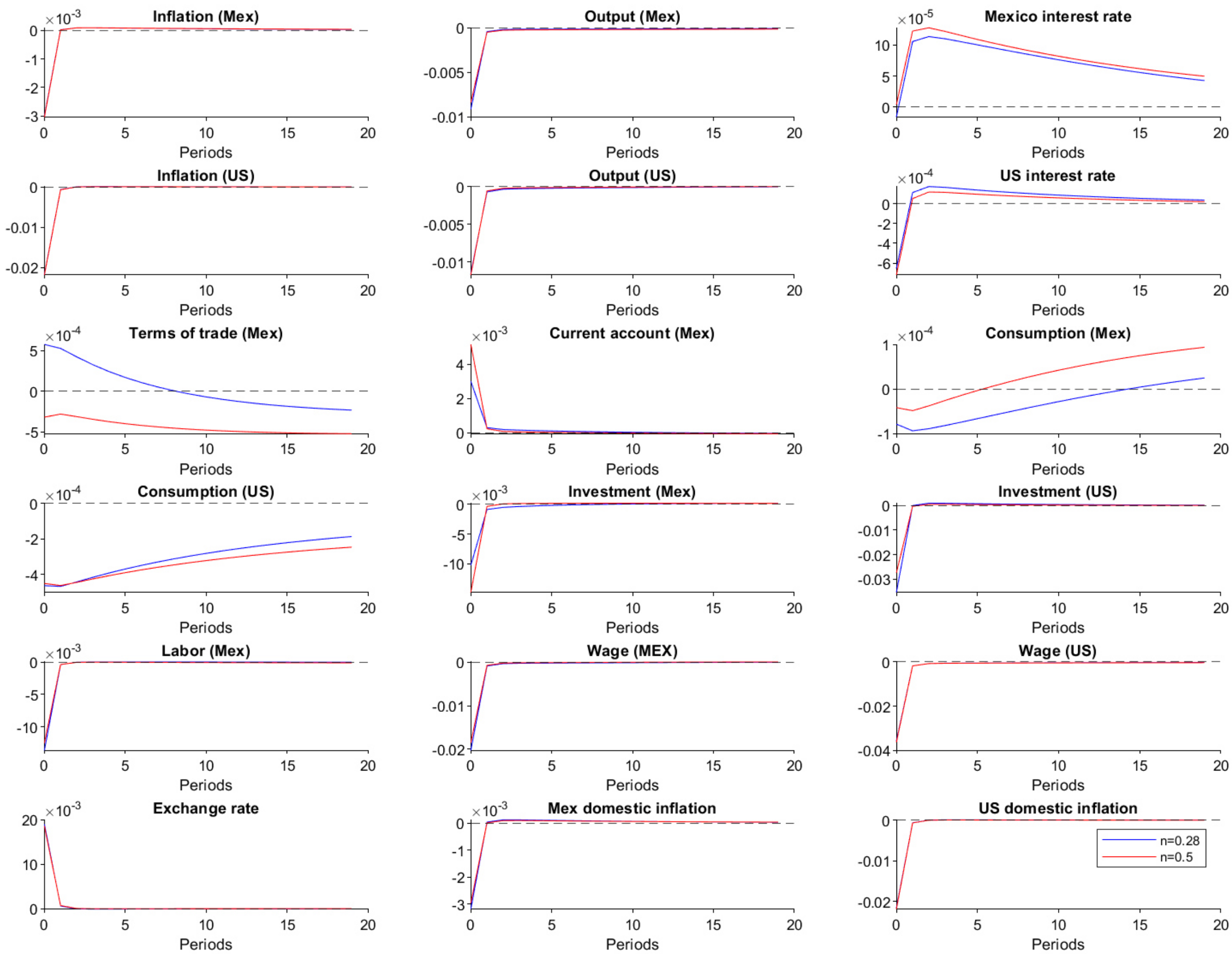
Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.16: Impulse responses under a positive 1% productivity shock originating in the US with alternative parameters.



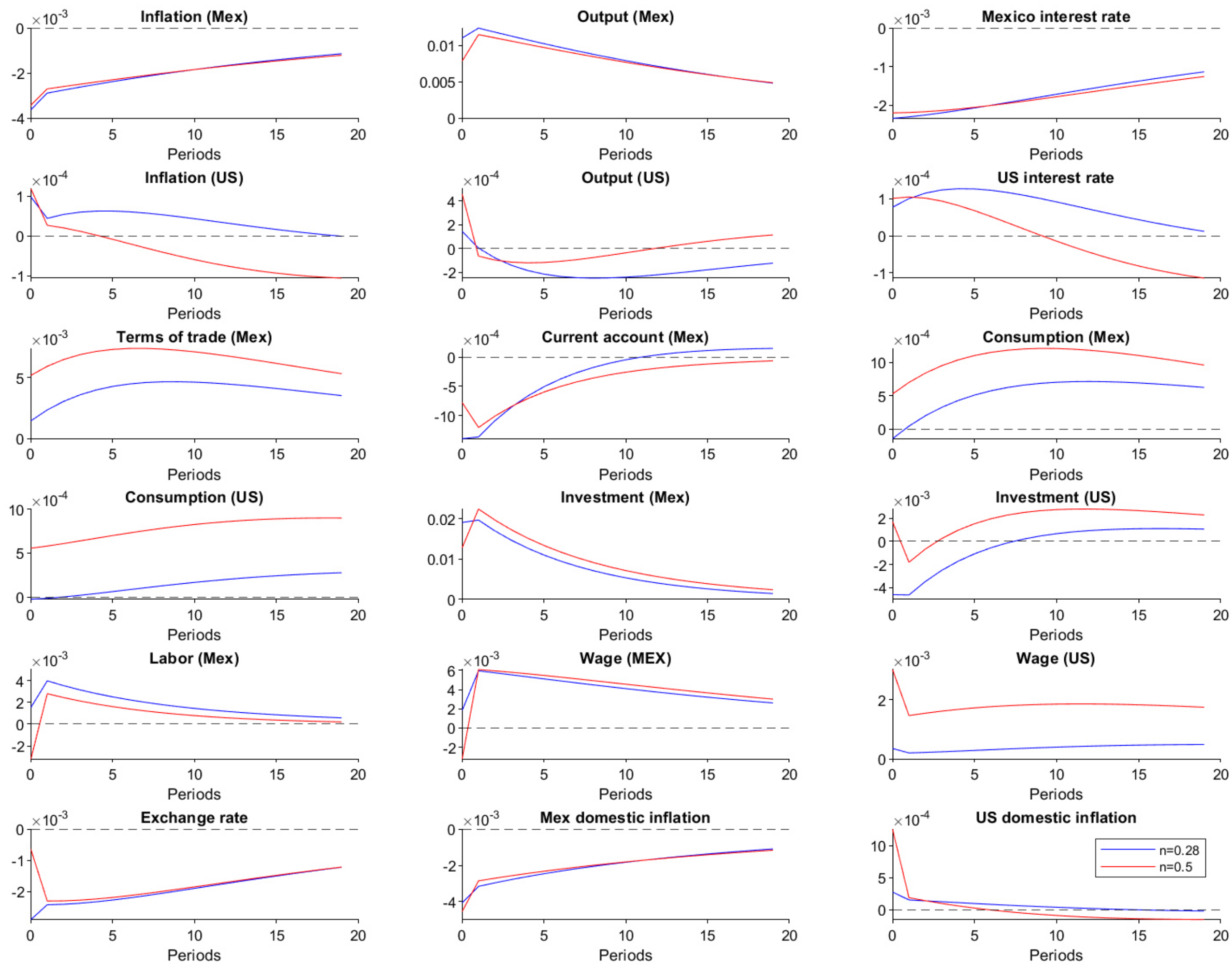
Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.17: Impulse responses under a contractionary 1% interest rate shock originating in the US with alternative parameters.



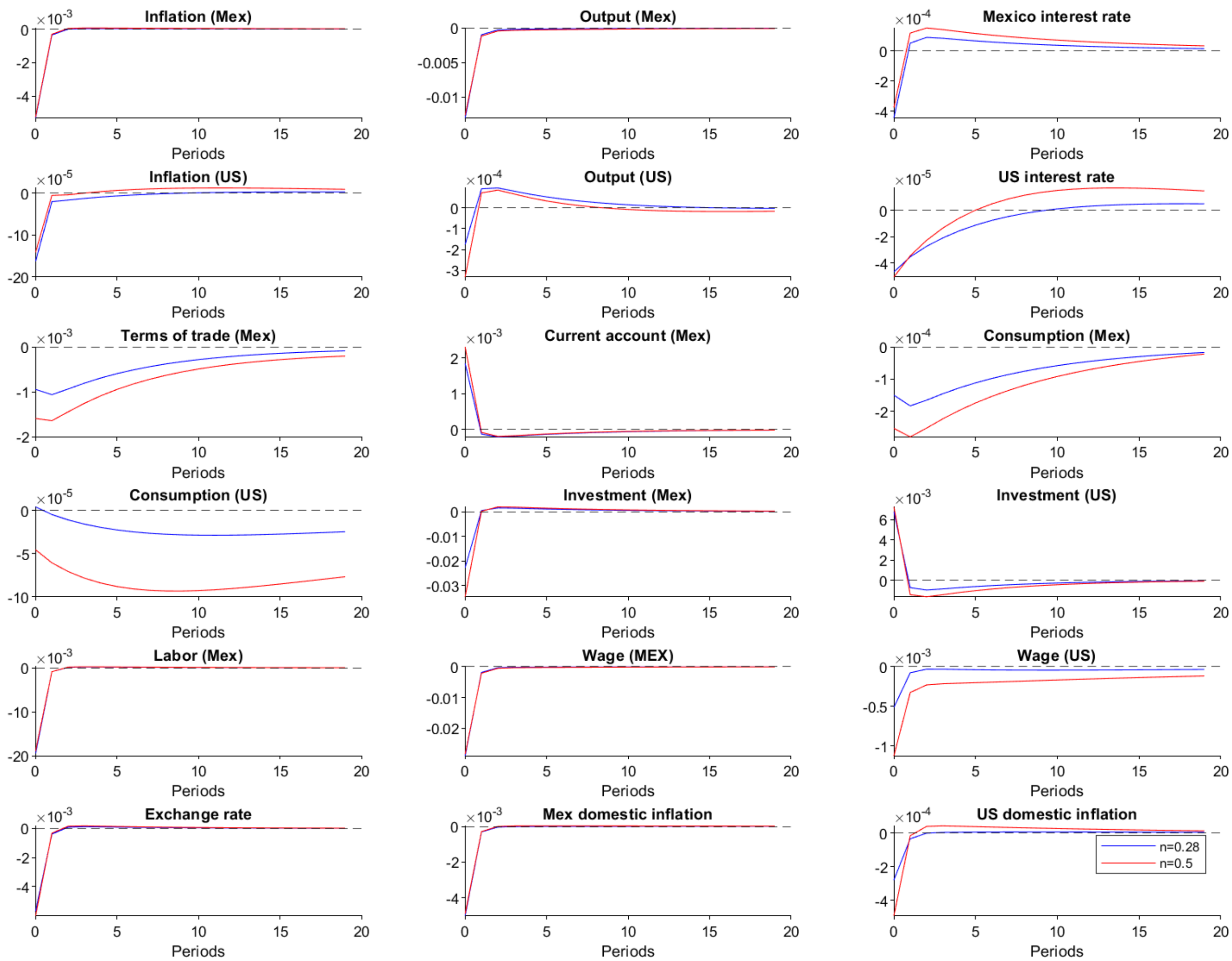
Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.18: Impulse responses under a positive 1% productivity shock originating in Mexico with alternative parameters.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Figure 4.19: Impulse responses under a contractionary 1% interest rate shock originating in Mexico with alternative parameters.



Vertical axes: % deviation from the steady state. Horizontal axes: quarters

Chapter 5

Conclusion

In this thesis we developed a two country New Keynesian DSGE model with incomplete asset markets, incorporating capital and investment spending and allowing for asymmetric size between countries. The calibration was made using the US as the foreign (advanced) economy and Mexico as the home (emerging) economy. The countries differentiate through an asymmetry in the asset market structure, a transaction cost for the home bond and asymmetry in the country size. The analysis looked at 5 shocks: a global productivity shock, a US productivity shock, a Mexico productivity shock and home and foreign interest rate shocks from the Mexico and the US.

The home country shocks don't importantly affect the foreign economy but the foreign economy shocks affect in a considerable way the home endogenous variables. Global positive productivity shocks affect output in a similar way in both countries and have complementary spillover effects, but we find differences in the terms of trade, wage and labor from the two countries. These differences depend largely on the degree of price stickiness.

If the central bank doesn't react to the exchange rate fluctuations in a Taylor rule, the spillover effects from a positive US productivity shock become complementary, if the central bank targets the exchange rate the spillover effects are initially competitive since the interest rate reacts a lot to avoid a depreciation. The interest rate shocks are competitive between the two countries. Nevertheless, Mexico can improve the negative effects from this type of external policy shocks if the Taylor rule doesn't react to changes in the exchange rate.

Policy measures to mitigate competitive demand shocks require improved policy coordination to prevent international risks from spilling over into the domestic economy. Policy shocks usually attract capital to the country offering higher returns. Consequently, policy shocks in advanced economies can inadvertently cause capital inflows into emerging markets.

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