The effect of foreign direct investment on a small and open economy's macroeconomic stability: the case of Mexico - a DSGE approach*

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Abstract

Since the 1990s, emerging economies have seen an increase in foreign direct investment coming from developed countries, resulting in higher economic growth and greater business cycle stability of target countries. While it is accepted that economic growth is an outcome of inflows of foreign direct investment, the effect of such inflows on a country's macroeconomic stability is a phenomenon that has received less attention. This paper develops a small open economy DSGE model calibrated for the Mexican economy in order to study the outcome of different openness levels on the business cycle. I find a greater presence of foreign direct investment results in higher stability of the target country's business cycle.

***Key words*:** FDI, DSGE, Macroeconomics, Business cycle stability, Emerging market economies.

1 Introduction

Foreign direct investment (FDI) traditionally has been seen as an important factor in emerging economies' growth and development. However, there is no such consensus regarding the effect that openness to these inflows may have on emerging market economies' macroeconomic stability, i.e., whether these inflows increase or decrease the response of the business cycle to price changes, productivity shocks, etc. This lack of consensus on the role of

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FDI on the volatility of macroeconomic variables brings the question on what is the optimal policy regarding the openness to these inflows when considering a macroeconomic stability target, that is, the existence of mild fluctuations in the business cycle and raises the following research question: does a greater attraction of FDI inflows develop into higher macroeconomic stability to face different shocks?

2 Literature review

The literature has focused in studying the effects of FDI on economic growth, finding there are direct and indirect effects. Direct effect are related to long-term economic growth as the result of capital formation, thus a larger fixed capital stock than that of an autarky economy (Fan & Dickie 2000). On the other hand, indirect effects relate to increases in productivity due to transfer of advanced production processes, knowledge, institutions and infrastructure, allowing to reduce the technological gap between developed and developing countries (Lee & Tcha 2004; Fan & Dickie 2000; Borensztein, et al. 1995), implying the existence of a long-term convergence among countries.

This line of thought offers a similar argument as Sachs (1996), since long-term growth is the result of fast increases rather than gradual capital increases in view of the existence of poverty traps. However, it is recurrently pointed out that in order to benefit from these indirect effects there is a minimum human capital threshold (Borensztein, et al 1995; Makki Somwarn 2004; Kotrajaras, et al. 2011; Lee & Tcha 2004) and some degree of financial development (Alfaro, et al. 2000), otherwise the target country will not be able to benefit from the positive externalities. As a consequence, FDI inflows would result in a large resources injection and may result in adverse outcomes as those described by Moyo (2009) when looking at Sub-Saharan Africa. Although Moyo (2009) does not, in a strict sense, talk about FDI inflows, it is still relevant because the mechanism of foreign aid on target countries can be similar to that of FDI.

In addition to these indirect effects, there may be a positive effect of FDI on commerce in light of the target's increased access to international markets (Fan & Dickie 2000; Baliamoune-Lutz 2004). This is particularly true for the case of vertical FDI[1] (Sayek 2009), because multinational firms are looking to produce raw in the host country and export to the home country and continue with the production of the final good. This positive effect in commerce may allow emerging market countries to attain higher growth rates due to higher export incomes, thus allowing the funding of domestic and foreign goods consumption and an increase in savings and,

[1]Vertical FDI refers to investment by multinational firms to secure access to producer goods or for distribution of final goods.

hence, higher domestic investment levels, resulting in even higher economic growth.

This vision of FDI resulted in a considerable increase of FDI inflows to emerging market economies during the 1990s, going from $2,148 millions[2] in 1970 to $5,468 in 1980 to $100,468 in 1994, and $684,046 in 2014 (UNCTAD 2019). This translates to 16.2%, 10.45%, 39.41%, and 51.10% of the world total, respectively.

Even though it would seem that these levels FDI inflows is a phenomenon that belong only to the 1980s and 1990s, truth is that such levels were observed from the late 19th century until the beginning of the World War I (te Velde 2006) due to the development of railway systems for the reduction of transportation costs in countries like India and Mexico. These FDI inflow levels are only observed again from 2004, being the main difference that nowadays target countries have a greater participation in global financial markets (Deveroux & Sutherland 2008) than during the 1900s and 1910s. However, the great war resulted in the interruption of FDI inflows in developing countries and the destination of resources towards the production of armament. This allows us to think that a large factor in the increase of FDI inflows during the 1990s was the end of the great conflicts of the 20th century, which facilitated the resume of overseas investments from developed to old developing countries and the introduction of new target economies such as former soviet republics. These former socialist countries had not received FDI inflows until the collapse of the Soviet Union in 1991, and it was only after the end of the Cold War that they showed a positive GDP growth tendency once the transition period with negative growth rates had ended. However, this positive outcome was only possible because of the high levels of human capital these countries had, and that their main problem was outdated physical capital and institutions. Hence, FDI inflows had a major role in the development of Eastern Europe and the Balkans (Lee & Tcha 2004).

It is important to note the share of Asian countries in the reception of FDI, since during the 1990s they attracted 69.04% of the inflows directed to emerging market economies, while in 2005 and 2017 they represented 58.21% and 68.29% of these inflows, respectively (UNCTAD 2019). In the meantime, Latin America captured 23.21% in 1990, 19.68% in 2005, and 20.64% in 2017, while Eastern Europe and the Balkans received 12.4% on average, and Africa is constantly receiving an average of 2.96% of the FDI inflows destined to emerging market economies. It must be noted that the case of Africa is atypical, because since the 1990's it has lost participation in the pool of FDI inflows to emerging market economies, making it rely mainly in foreign aid packages.

This increase in FDI inflows helped the economic growth of emerging

[2]All figures in US dollars.

economies, going from $3,348,379 millions and FDI inflows that represented 0.17% of GDP in 1980 to $28,507,467 millions and FDI inflows that account for 2.4% of GDP in 2015 (UNCTAD 2019). In the case of African economies, data shows that in this period they only had a four times increase in GDP, going from $302,531 to $1,129,863 millions, allowing us to see the importance of FDI inflows for the GDP trend, specially after the year 2000. We also observe a strong correlation between economic growth and FDI inflows, being 0.8262, 0.9763, 0.9754, and 0.8272 during the 1970-2017 period for Africa, Latin America, Asia and the emerging Europe, respectively.

When focusing in Mexican data, we find thet there is a change in the trend of FDI inflows during the 1990s. However, this trend is interrupted in the year 2000 and is accompanied by a period of high volatility. Nuunekamp & Alatorre (2007) find that larger FDI inflows had a positive impact in the creation of jobs in the Mexican manufacturing sector, allowing for a better allocation of unskilled workers in the country, while Alguacil, Cuadros & Orts (2002) find that FDI had a positive effect on exports and growth, implying that the grater openness that resulted from NAFTA in 1994 helped to address the problems in the Mexican labor market and increased the gains from trade, allowing for greater growth at a regional level.

Although the gains from FDI are many when we talk about economic growth, we must also consider the consequences it may have on macroeconomic stability, given that it is desirable to have a macroeconomic stability due to the fact that high volatility in the business cycle generates uncertainty and distrust in consumers and investors, which has a negative effect on economic activity. On one hand we find authors such as Sayek (2009) that hold that FDI inflows can reduce the negative real effects of inflation on the host economy in virtue of the possibility of having an investment smoothing behavior, similar to the role of Euler's equation in consumption behavior, and like Fan & Dickie (2000) that argue that a greater openness helps to mitigate the effects of negative shocks on the target country because it is the most stable funding method as a result of its long-term nature[3].

On the other hand, Lartey (2006; 2007; 2008) and Moyo (2009) hold that FDI inflows have hindered the developing world. One of the most common arguments is the possibility of crowding out domestic investment in favor of foreign investment, however Makki & Somwaru (2004) find empirical evidence that, although not significant, FDI inflows have a positive effect on domestic investment, hence this common argument against this type of inflows is the result of a specific case and not attributable to a presumed competitive nature of FDI. More convincingly, Lartey (2006; 2007; 2008) makes a series of studies taking the cases of Argentina, Philippines and

[3]Other funding methods are equity, bonds, official flows, commercial bank loans

Africa Sub-Saharan, arguing that without an appropriate response from the monetary authorities, it is possible to find a Dutch disease effect caused by the entrance of FDI inflows to specific sectors of the host economy, which is a usual occurrence in these countries.

In order to measure the macroeconomic stability of Mexico, I use Dynare to compute the theoretical moments of key macroeconomic variables. Moreover, I simulate shocks to (i) the unit price of foreign investment, (ii) the total factor productivity, and (iii) the foreign output to study the dynamics of the model. Finally, it is important to note that, although the model used may be more appropriate for studying dynamics of national content on capital formation, Montiel & Reinhart (1999) find that is a well documented fact that FDI inflows has been used to finance domestic investment with high contents of imported capital. This implies that the following model is still useful for studying the macroeconomic effects of FDI inflows.

3 Model

Using Lartey (2006) as a starting point, I build a DSGE model that considers the role of FDI inflows in the context of a small and open economy.

3.1 Households

The representative household derives utility from its consumption level (C_t) and leisure, i.e., it loses utility from time spent working (L_t), hence it may be represented by the following utility function:

$$U_t(C_t, L_t) = \frac{C_t^{1-\sigma}}{1-\sigma} - \psi \frac{L_t^{1+\upsilon}}{1+\upsilon} \tag{1}$$

Moreover, households choose whether to save using bonds (B_t) denominated in terms of the domestic good[4] or to invest in the representative firm in exchange of a share in the utility (X_t) or "stocks"[5]. In consequence, the representative household faces the following budget constraint:

$$P_t C_t + B_{t+1} + \frac{\kappa}{2}(B_{t+1})^2 + V_t X_{t+1} = (1+r_t)B_t + (V_t + D_t)X_t + W_t L_t + \tau_t \tag{2}$$

Where $\frac{\kappa}{2}(B_{t+1})^2$ is an adjustment cost of holding bonds that is introduced in the model to guarantee the determination of the steady state in Lartey (2006; 2008). Lartey (2008) mentions this cost may be

[4] In this model the domestic good is used as the numerate.

[5] In equilibrium $X_t = i, \forall t$.

interpreted as a cost for financial intermediation done by local firms owned by the representative household and that operate in perfect competition, resulting in the transfer of any utilities for financial intermediation in a transfer (τ_t) to the households. The relative price per unit of the aggregate consumption good is given by $P_t = \left[\gamma + (1-\gamma)(P_t^m)^{1-\xi}\right]^{\frac{1}{1-\xi}}$, where P_t^m is the unit price of the imported consumption good, the terms V_t y D_t correspond to the representative firm's value and its dividends, respectively while, r_t is the real interest rate y W_t are wages. The different parameter are the household discount factor (β), the inverse of the intertemporal elasticity of consumption (σ), the coefficient of labor in the utility (ψ), the inverse of the intertemporal elasticity of labor (υ), the coefficient of the adjustment cost of bond holding (κ), the share of domestic goods in the national consumption basket (γ), and the substitution elasticity between domestic and foreign goods in consumption (ξ). Therefore, the household faces the maximization problem described by

$$\max_{\{C_t, L_t\}} \quad U_t(C_t, L_t)$$

$$\text{s.t.} P_t C_t + B_{t+1} + \tfrac{\kappa}{2}(B_{t+1})^2 + V_t X_{t+1} = (1+r_t)B_t + (V_t + D_t)X_t + W_t L_t + \tau_t$$

Then, the representative household chooses a combination of domestic (C_t^h) and imported goods (C_t^m) that minimizes its expenditure level such that a certain threshold of aggregate consumption is met. This selection process may be described by the following minimization problem:

$$\min_{\{C_t^h, C_t^m\}} \quad C_t^h + P_t^m C_t^m$$

$$\text{s.t.} C_t = \left[\gamma^{\frac{1}{\xi}}(C_t^h)^{\frac{\xi-1}{\xi}} + (1-\gamma)^{\frac{1}{\xi}}(C_t^m)^{\frac{\xi-1}{\xi}}\right]^{\frac{\xi}{\xi-1}}$$

3.2 Representative firm

The representative firm is divided in two different areas. First an area that captures investment from foreign investors and households. Secondly, an area that takes the investment to produce capital and manufacture consumption goods.

3.2.1 Investment area

The firm's investment area captures resources in order to generate investment units (I_t) at the least feasible cost. These resources may come from the domestic market (I_t^h) or overseas (I_t^f), where the foreign investment good is different to its domestic counterpart, thus it has a different price (P_t^f), while the domestic investment good is denominated in terms of the domestic consumption good units. Hence, each period the firm faces the following minimization problem:

$$\min_{\{I_t^h, I_t^f\}} \quad I_t^h + P_t^f I_t^f$$

$$\text{s.t.} I_t = \left[\mu^{\frac{1}{\rho}} (I_t^h)^{\frac{\rho-1}{\rho}} + (1-\mu)^{\frac{1}{\rho}} (I_t^f)^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}$$

Where μ is the share of domestic investment in the aggregated investment good and ρ is the substitution elasticity between domestic and foreign investment goods.

3.2.2 Production area

Once that the aggregated investment good is produced, the production area transforms them into capital units (K_t) in order to produce domestic consumption goods (Y_t), solving the problem that maximizes the discounted value of future dividends, i.e., maximizing the firm's present value.

$$\max_{\{K_{s+1}, I_s, L_s\}} \quad E_t \sum_{s=t}^{\infty} \Lambda_s \left[Y_s - P_s^I [I_s + \tfrac{\phi}{2} (\tfrac{I_s}{K_s} - \delta)^2 K_s] - W_s L_s\right]$$

$$\text{s.t.} Y_s = e^{a_s} K_s^{\alpha} L_s^{1-\alpha}$$

$$\text{K}_{s+1} = (1-\delta) K_s + I_s$$

Where the time period s does not have to necessarily match the time period t. The parameters relate to the coefficient of the capital adjustment cost (ϕ), the depreciation rate of the capital (δ), y the share of capital in the production technology (α). Also, $P_s^I = \left[\mu + (1-\mu)(P_s^f)^{1-\rho}\right]^{\frac{1}{1-\rho}}$ is the price per unit of aggregated investment or the capital replacing cost, while $\Lambda_s = \beta^{s-t} \left(\frac{C_t}{C_s}\right)^{\sigma}$ is the stochastic discount factor and dividends for time period s are defined by

$$D_s = Y_s - P_s^I[I_s + \frac{\phi}{2}(\frac{I_s}{K_s} - \delta)^2 K_s] - W_s L_s \tag{3}$$

Finally, we find that the value of the representative firm is given by the discounted value of its dividends, that is

$$V_t = E_t \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{C_t}{C_s}\right)^{\sigma} D_s \tag{4}$$

3.3 Foreign economy, commerce, and market clearing

The foreign economy devotes a share of its output to the acquisition of domestic goods according to the function introduced by Gertler, Gilchrist & Natalucci (2003), and used by Lartey (2008).

$$exports_t = \Omega \left(\frac{1}{P_t^x}\right)^{\omega} Y_t^* \tag{5}$$

Where P_t^x is the price of the export unit and Y_t^* is foreign output, while Ω is the share of the foreign output that is used to purchase domestic consumption goods, and ω is the price elasticity of the exports demand. As a result, net exports of real goods is defined as $NX_t = exports_t - P_t^m C_t^m - P_t^f I_t^f$. The current account in real terms is described by

$$CA_t = r_t B_t + NX_t \tag{6}$$

The feasible conditions related to the foreign sector of this economy are: (i) the supply of foreign goods (Imports_t^m) has to equal its demand (C_t^m) in the imported consumption goods market, (ii) the foreign investment supply (Imports_t^f) must equal its demand (I_t^f) in the investmet goods imports, and (iii) the supply of aggregated investment ($Investment_t$) must equal its demand (I_t) in the investments market. Finally, the market clearing condition is

$$Y_t = C_t^h + I_t^h + exports_t + P_t^I \frac{\phi}{2}(\frac{I_t}{K_t} - \delta)^2 K_t \tag{7}$$

4 Solving the model

the optimal choice between domestic and foreign goods for the final consumption basket yields the following demand functions:

$$C_t^h = \gamma \left(\frac{1}{P_t}\right)^{-\xi} C_t \tag{8}$$

$$C_t^m = (1-\gamma)\left(\frac{P_t^m}{P_t}\right)^{-\xi} C_t \tag{9}$$

From the representative household's first order conditions (FOC) we get the following efficiency conditions:

$$C_t^{-\sigma} = \beta E_t\left[C_{t+1}^{-\sigma}\frac{(1+r_{t+1})}{1+\kappa B_{t+1}}\frac{P_t}{P_{t+1}}\right] \tag{10}$$

$$\frac{1+r_{t+1}}{1+\kappa B_{t+1}} = \frac{E_t[V_{t+1}+D_{t+1}]}{V_t} \tag{11}$$

$$L_t^v = \frac{1}{\psi}\frac{W_t}{P_t}C_t^{-\sigma} \tag{12}$$

Where equation (10) is Euler's equation, (11) is the no-arbitrage condition, and (12) ys the labor supply. Then, from the investment area of the representative firm we get

$$I_t^f = (1-\mu)\left(\frac{P_t^f}{P_t^I}\right)^{-\rho} I_t \tag{13}$$

$$I_t^h = \mu\left(\frac{1}{P_t^I}\right)^{-\rho} I_t \tag{14}$$

While from the production area we find the following efficiency conditions:

$$\mathrm{E}_t\Lambda_{t+1}\left[\alpha\frac{Y_{t+1}}{K_{t+1}} - P_{t+1}^I\left(I_{t+1} + \frac{\phi}{2}(\frac{I_{t+1}}{K_{t+1}}-\delta)^2 - \phi(\frac{I_{t+1}}{K_{t+1}}-\delta)\frac{I_{t+1}}{K_{t+1}}\right) + (1-\delta)\lambda_{t+1}\right] = \lambda_t \tag{15}$$

$$P_t^I\left(1+\phi(\frac{I_t}{K_t}-\delta)\right) = \lambda_t \tag{16}$$

$$(1-\alpha)\frac{Y_t}{L_t} = W_t \tag{17}$$

Now, $Q_t = \frac{\lambda_t}{P_t^I}$ is Tobin's Q[6], in other words, the value added to the firm's present value of the profits per capital unit invested. I must be noted that in the steady state Tobin's ratio is met, i.e,, the capital unit is correctly priced ($\frac{\lambda}{P^I} = 1$).

Then, we have the following endogenous variables C_t, C_t^h, C_t^m, L_t, B_t, X_t, V_t, D_t, r_t, W_t, λ_t, K_t, I_t, I_t^h I_t^f, P_t^I, Q_t, Y_t, $exports_t$, NX_t, and CA_t, and the exogenous variables a_t, P_t^f, P_t^x, P_t^m, and Y_t^*. It must be noted that in the steady state are no adjustment costs, the real interest rate is constant

[6]Where λ_t is the Lagrange multiplier of the firm optimization problem and corresponds to the shadow price of a capital unit.

and all future dividends are the same, allowing us to rewrite the firm's value as a perpetuity:

$$V_{ss} = \frac{D_{ss}}{r_{ss}} \tag{18}$$

4.1 Exogenous processes

In order to close the model, we introduce the following AR(1) processes to model shocks to variables that were previously exogenous in the model[7].

$$a_{t+1} = \eta_a a_t + \varepsilon^a_{t+1} \tag{19}$$

$$P^f_{t+1} = (P^f_t)^{\eta_{pf}} e^{\varepsilon^{pf}_{t+1}} \tag{20}$$

$$P^m_{t+1} = (P^m_t)^{\eta_{pm}} e^{\varepsilon^{pm}_{t+1}} \tag{21}$$

$$P^x_{t+1} = (P^x_t)^{\eta_{px}} e^{\varepsilon^{px}_{t+1}} \tag{22}$$

$$Y^*_{t+1} = (Y^*_t)^{\eta_{Y^*}} e^{\varepsilon^{Y^*}_{t+1}} \tag{23}$$

5 Calibration

The different model parameters were calibrated for the Mexican economy using quarterly data from 1995QII to 2006QIV[8] and relevant literature. Table 1[9] shows a summary of the parameter calibration results.

[7] I assume that the total factor productivity $a = 0$ in the steady state, while relative prices and foreign output are 1 ($p^f = p^m = p^x = y^* = 1$).

[8] 2006 is set as the last year for calibration in order to avoid distortions from the Great Financial Crisis.

[9] β was calibrated using data from Mexico's Central Bank (http://www.banxico.org.mx/Si eInternet/consultarDirectorioInternetAction.do?sector=18&accion=consultarCuadroAnalitico&idCuadro=CA51&locarle=es) and INEGI (https://www.inegi.org.mx/temas/inpc/). υ was calibrated using the share of men and women in the economically active population (`http://www.stps.gob.mx/gobmx/estadisticas/pdf/perfiles/perfil%20nacional.pdf`) and the volatility of labor supply mentioned by Greenwood, Hercowitz y Huffman (1988) for each gender. γ was calibrated with data from INEGI (`https://www.inegi.org.mx/sistemas/bie/`) on the share of domestic and imported goods in the Mexican consumption basket. μ was calculated with data from INEGI (`https://www.inegi.org.mx/sistemas/bie/`) on the share of construction, machinery and domestic and foreign equipment in the gross fixed capital formation. δ was calibrated using Kehoe's method with OECD data on private investment (`https://stats.oecd.org/Index.aspx?DataSetCode=QNA`) and INEGI's data on capital consumption (`https://www.inegi.org.mx/sistemas/bie/`). Ω was calibrated using

For households related parameters, I find using data from Banco de México that the average quarterly real interest rate is 4.33% annual, thus the household discount rate is establish as $\beta = 0.99$ in a quarterly basis. Then, following Aguiar & Gopinath (2007) and Alvarez-Parra, et al. (2011), I set the inverse of the intertemporal elasticity of consumption to $\sigma = 2$, given the fact that both studies calibrate this parameter for Mexico. The adjustment cost of bond holding is set to $\kappa = 0.01$ as in Lartey (2008), being in the 0.005-0.01 range that is common in the literature.

The inverse of the intertemporal elasticity of labor was calibrated following the suggestions of Greenwood, Hercowitz y Huffman (1988), whom mention that the intertemporal elasticity of labor can be estimated using 0.3 as the variation of the average labor supply of adult males and 2.2 as the equivalent for women, implying the true value lies within the 0.3-2.2 range. Hence, I calculate the weighted average of these numbers used the share of men and women in the economically active population. This population was composed by 60.9% of men in 2019 according to a report on labor information offered by the Mexican labor ministry (Secretaria del Trabajo y Previsión Social), while this number was 65% in 2000. It is assumed that the male-female distribution was 65-35 during the calibration period, resulting in $\upsilon = 1.04$[10]. Following Deveroux, et al. (2006), the coefficient of labor in the utility was set to $\psi = 1$.

Regarding firm related parameters, the share of national goods in the consumption basket was calibrated using data from the Mexican statistics institution (INEGI) on private consumption and the import of goods and services, finding a value of $\gamma = 0.63$, while the substitution elasticity between domestic and foreign goods was set to $\xi = 0.83$ following Annabi, et al. (2006) for the Mexican industry. Using data from OECD and INEGI, I find using Kehoe's method that the average quarterly depreciation rate was 1.8535% during the calibration period. Then, using data on the participation of construction, machinery and domestic and foreign equipment in the gross fixed capital formation from INEGI, I find that the share of domestic investment is $\mu = 0.8$.

Following the traditional literature of real business cycles, I set the capital share in the production function to $\alpha = 0.33$. I also follow Lartey (2006) to set the substitution elasticity between domestic and foreign investment to $\rho = 1$, while the parameter related to capital adjustment costs is set to $\phi = 0.0443$ in order to replicate the investment-output ratio observed in the Mexican Data.

Finally, I set the price elasticity of exports demand to $\omega = 0.49$ following Annabi, et al (2006), and I calibrated the share of foreign output used in

WITS data (`htt ps://wits.worldbank.org/datadownload.aspx?lang=es`) and data from the FRED (`https://fred.stlouisfed.org`) on mexican imports and United States' output. All other parameters were found in the literature.

[10] $\frac{1}{\upsilon} = 0.65 * 0.3 + 0.35 * 2.2 = 0.965$

the purchase of Mexican goods using data from the FRED and WITS on Mexican exports to the United States, finding a value of $\Omega = 0.01$. The persistence of exogenous stochastic shocks is set to 0.95.

Table 1: Benchmark calibration of model parameters.

Parameter	Value	Description
β	0.99	Household discount factor
σ	2.00	inverse of the intertemporal elasticity of consumption
ψ	1.00	Coefficient of labor in the utility
υ	1.04	inverse of the intertemporal elasticity of labor
γ	0.63	Share of domestic goods in the national consumption basket
ξ	0.83	substitution elasticity between domestic and foreign consumption goods
κ	0.01	Adjustment cost of bond holding
μ	0.80	Share of domestic investment in the aggregated investment good
ρ	1.00	substitution elasticity between domestic and foreign investment goods
ϕ	0.04	Capital adjustment cost coefficient
δ	0.02	Depreciation rate of capital
α	0.33	Capital share in the production function
Ω	0.01	share of foreign output used in the purchase of domestic goods
ω	0.49	price elasticity of exports demand

5.1 Share of domestic investment in the aggregated investment good parameter

In this model, the parameter for the share of domestic investment in the aggregated investment good (μ) captures protectionist and openness policies that affect FDI inflows. This way, an increase in μ translates into greater barrier to the entry of FDI, while a reduction of the parameter results in

higher levels of FDI inflows. Regarding the actual share of FDI inflows in total investment, I assume foreign investors chose to invest 20% of total investment required by the representative firm. Although this assumption oversimplifies reality, this allows an easier introduction of taxes and other distorting mechanisms to the model.

6 Volatility and model dynamics

To study the stability of key macroeconomic variables to a higher presence of FDI inflows, I use Dynare to calculate the theoretical moments of output, consumption, labor, investment, and net exports using $\mu = 0.8$ and $\mu = 0.51$, and a Hodrick-Prescott filter with a smoothing coefficient of $\lambda = 1600$. This allows me to capture characteristics of emerging market economies such as volatilities of consumption, net exports and investment that are greater than the output volatility, and, similar to Lartey (2006; 2008), a negative correlation between output and the current account, as well as the right signs in the correlations between output and other key macroeconomic variables (Table 2 and Table 3). The consumption-output volatility ratio is similar to that of Alvarez-Parra, et al (2011), being the ratio reported by the model only 7.32% larger than the one observable in Mexican data when $\mu = 0.8$, while net exports volatility is 33.05% lower than the observed value for the benchmark calibration ($\mu = 0.8$). However, the model fails to capture the appropriate sign in the correlation between net exports and output.

While it is no surprise that the model is able to replicate a positive correlation for consumption, investment, and labor, it must be noted the model closely approximates to observed values (lvarez-Parra, et al. 2011). The theoretical moments show that a greater openness to FDI inflows translate in a lower consumption volatility relative to output, as well as lower volatility ratios for net exports and aggregated investment. These results allows to conclude that a higher levels of FDI inflows can generate greater macroeconomic stability.

Table 2: Standard deviations of key macroeconomic variables relative to output. Output data as percentage. Observed investment-output volatility ratio calculated from data on Mexican private investment from México ¿cómo vamos? (`https://mexicocomovamos.mx/?s=seccion&id=100`).

Variable	$\mu = 0.51$	$\mu = 0.8$	Data
Output	0.0946	0.0914	2.3500
Consumption	1.1025	1.1805	1.1000
Investment	1.8594	2.2484	2.2481
Net exports	0.9704	1.1247	1.6800

Table 3: Correlation between key macroeconomic variables and output.

Variable	$\mu = 0.51$	$\mu = 0.8$	Data
Consumption	0.9996	0.9990	0.9400
Investment	0.7523	0.8374	0.9200
Labor	0.7885	0.9637	0.9000
Net exports	0.9992	0.9990	-0.8200

In addition to volatility estimations, I simulated three different shocks in order to study the model dynamics: (i) a temporal increase in the price of the foreign investment unit (P_t^f), (ii) an temporal increase in domestic productivity (a_t), and (iii) a temporal increase in foreign output (Y_t^*)[11].

I must mention that the direction of some impulse-response when facing a reduction in price of the foreign investment unit are in a different direction than those in Lartey (2008) with a floating exchange rate. The reason for this is that while I set the parameter that controls the share of output destined to the purchase of domestic goods as $\Omega = 0.01$, Lartey (2008) assumes all output is used to buy consumption goods from the home economy (Ω=1). However, when using the calibration found in Lartey (2008), both models have impulse-response functions with the same direction.

6.1 Shock to the price of the foreign investment unit

When facing an unanticipated increase in the price of the foreign investment good, the representative firm reduces its demand for this good, substituting it with the domestic investment good. The higher price for this good also reflects in the higher capital replacement cost, hence the firm invests less given the fact that the benefit provided by an additional capital unit is less than its cost. In addition, there is an increase in labor, which diminishes it marginal rate of return. Although the real interest rate drops, dividends increase, which leads households to reduce their consumption levels in order to invest in the domestic firm. Now, even though there is a drop in the amount of imported consumption and investment goods, the effect of the increase in the price of foreign investment dominates and has a negative effect in net exports, resulting in its deterioration. Finally, the increase in savings has an effect that dominates over net exports, resulting in the improvement of the current account (Figure 1).

[11] In this version I only present the first shock due to the page limit.

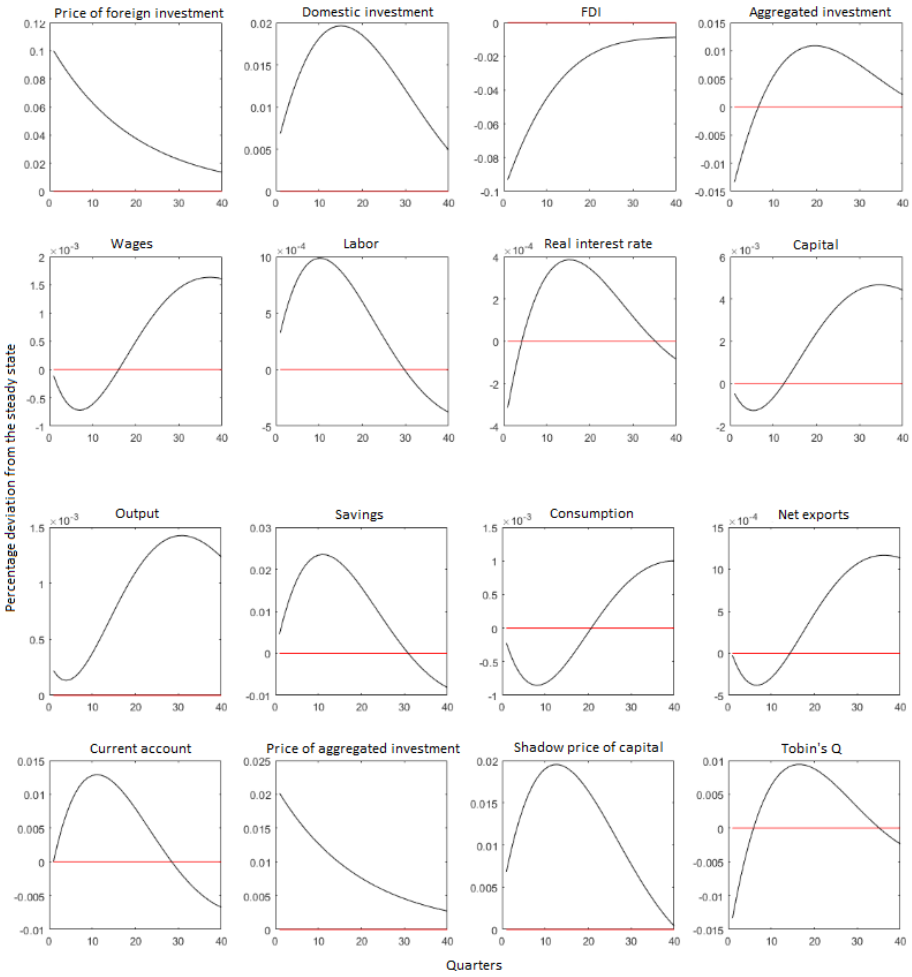

Figure 1: Impulse-response functions from a shock to the price of the foreign investment unit using benchmark calibration.

7 Conclusion and final observations

While it is widely accepted that FDI inflows boosts economic growth, determining whether it has a positive or negative effect in a country's macroeconomic stability requires a far more complex exercise that uses a large amount of variables in a general equilibrium framework. However, this paper shows that FDI inflows can have a positive on macroeconomic stability as per the result exhibited in Table 2. I find that a lower consumption volatility relative to output is attained when decreasing domestic participation from $\mu = 0.8$ to $\mu = 0.51$, resulting in a reduction of this stability measure from 1.1805 to 1.1025. It is worth mentioning that, although this model does not manage to replicate the correlation direction of all macroeconomic variables, it manages to produce a $\frac{\sigma_c}{\sigma_y} > 1$ ratio, which is characteristic to emerging market economies and contradicts the traditional theory from the neoclassical growth model.

This model adds to the limited literature on the effects of FDI inflows to the macroeconomic stability in a general equilibrium framework, introducing a simpler model than Lartey (2006; 2008) and Sayek (2009), serving as a starting point in this topic that usually is a source of debate. Future work that may use this model as a reference may be those that seek to include the effects of human capital, since as noted by Borensztein, et al. (1995) and Kotrajaras, et al. (2011), this is a factor that complements FDI inflows in producing economic growth, which leads to questions regarding the effect FDI may have in the stability of the host's business cycle when human capital is taken into account. Lastly, this model may be useful to study the role of scoring institutions should an explicit FDI supply function be introduced.

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