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IMPORT PRICE SETTING DYNAMIC WITH TAX ON IMPORT IN DSGE MODEL

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Abstract: *In this study we are looking to derive the Calvo (1983)-based price-setting Phillips curves for import sector, with tariff, in a small open-economy dynamic stochastic general equilibrium (DSGE) model. We consider import sector in such a way that consists of monopolistically competitive firms that buy a homogenous good in the world market. The imported product is turned into a differentiated good and then sold to the perfectly competitive aggregation sector which combines the imported varieties. We follow import tax impact through its inclusion in the marginal cost function of importing firms .We found that a raise of the import tariff determine a wedge between the price paid by the importers in the world market and the local currency price applied in the domestic market. This wedge acts as an increase in their real marginal cost and therefore boosts foreign goods inflation. Also in final equation appeared a parameter to responds for price stickiness.*

Keywords: *Phillips Curve, Tax on Import, Small Open Economy, Dynamic Stochastic General Equilibrium*

JEL Classification: *C61, E62, F41.*

1. INTRODUCTION

This paper investigates price setting dynamics in an small open economy in the context of an dynamic stochastic general equilibrium for import sector In the presence of import tax.

Some countries, particularly developing countries, for reasons such as revenue or protect of domestic industries from foreign competition and also to create a steady demand in the home market for domestic goods imposed high import tariffs.

Considering that changes in import tax may affect supply and demand and, as a consequence, producer and consumer prices, one should expect other macroeconomic variables to be affected, such as the terms of trade and the real exchange rate.

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To describe all Considerable relationship in an economy it is not possible to concentrate only on the behavior within the economy. A relationship with the foreign economies could be in some respects important. The participation gives some benefits. According to Bhagwati, Panagariya and Srinivasan (1998), there can be higher welfare especially due to a possibility of international trade in open economies.

The previous word can be supported with the situation of the Iran economy as a small open economy. The import or export ratio to GDP is relatively high (but comparable with similar countries). If we want to analyze behavior of the Iran economy it is necessary and inevitable to take the foreign sector into account.

In dynamic stochastic general equilibrium models, the first step to make a model is usually to make a closed economy model. These models use a condition of a closed economy with no connection to the rest of the world. They are able to describe some basic characteristic of the economy where is more detailed analysis of the behavior and the model indicates a suitable approximation. but considering it as open , allows to cover a connection to outside of the economy.

Price system played a crucial role in macroeconomic models. Real wages that equate demand for labour to its supply, determined the level of employment and that determined the level of output. Income is either spent on the current consumption or saved for the future consumption. The real sector equilibrium is guaranteed by equality between the saving and investment. The price level is proportional to supply of money and the monetary neutrality is maintained by perfectly flexible real prices. The major objective of government is to ensure law and order so that business enterprises could thrive. As such less intervention is considered better. Capital accumulation and saving drives the dynamics of economy in the classical system. More saving means more investment and larger amount of capital stock and higher output.

The importance of understanding pricing behavior is underlined by the vast literature on international pricing.

2. PREVIOUS RESEARCH

Since developed countries apply lower import tariffs there is a lack of studies concerning the transmission effects of an import tariff shock in the economy with the dynamic stochastic general equilibrium (DSGE) modeling. Studies that examine the macroeconomic effects of fiscal policy on international trade mostly focus on government spending (e.g., Clarida and Findlay, 1992; Anwar, 1995 and 2001; Müller, 2008). Most research on the effects of tax policy on trade has been theoretical (e.g., Helpman, 1976; Baxter, 1992; Frenkel, Razin, and Sadka, 1991).

An exception is Summers (1988) who conducted an empirical investigation on the hypothesis that decreases in capital income taxes lead to capital inflows and a corresponding decrease in net exports; he did not find empirical support for this hypothesis. Another is Keen and Syed (2006) who estimated the effect of commodity and corporate income taxes on country net exports using panel data from OECD countries. They found that commodity taxes have no impact on trade whereas an increase in corporate taxes initially increases the trade surplus, then reduces it.

Krugman (1987) introduced the term" Pricing to Market" to describe monopolistic firms that choose to set different prices in different national markets because of different market conditions. A number of recent papers examine price setting, nominal rigidities and the nature of inflation dynamics. For example, Gali and Gertler (1999) and Gall, Gertler and Lopez-Salido (2001) have recently studied inflation dynamics in the United States and euro area. They estimate a structural equation for inflation (also known as a New Phillips Curve) that evolves from a model of staggered nominal price setting by monopolistically competitive firms.

The estimation results of Gall and Gertler (1999) and Gall, Gertler and Lopez-Salido (2001) seem to support the forward looking nature of price setting behavior. They argue that the model captures the pattern of both euro area and US inflation measured by the GDP deflator (although some signs of inertia can be found). However, these papers, although very insightful, ignore the open economy aspect of price setting.

Many important questions concerning the exact form of price setting and their implications for an open economy have been raised in the new literature on the ' ' new open economy macroeconomics ' ' (see Lane 1999 for a survey). The new open economy literature was initiated by Maurice Obstfeld and Kenneth Rogoff in their 1995 article, " Exchange Rate Dynamics Redux." This growing body of literature addresses open economy issues in a micro-founded general equilibrium framework.

The Obstfeld and Rogoff model is based on the conventional price setting assumption of producer currency pricing. In this case, prices are set in the seller's currency and the law of one price holds. Under producer currency pricing, because the producer sets prices in home currency but does not change them frequently (prices are sticky), prices faced by consumers in the export market fluctuate with changes in the nominal exchange rate, so that there is complete pass-through of exchange rates to destination-country prices.

The Obstfeld and Rogoff model has been modified in many aspects in the recent literature. One of the first modifications was by Betts and Devereux (1996) who incorporate local currency pricing into the Obstfeld and Rogoff framework. The alternative convention of local currency pricing means that prices are set and sticky in the buyer's currency. In this case, changes in nominal exchange rates do not affect goods prices in the local market of sale, ie there is zero pass-through of exchange rate changes to import prices (in the short run).

In this situation, deviations from the law of one price are possible, as exchange rate fluctuations have no impact on destination-country customer prices. Such rigid price levels mean that nominal exchange rate shocks pass through into real exchange rates.

The literature has been growing rapidly, as more and more researchers are seeking a superior alternative to the Mundell-Fleming-Dornbusch model. There are at least two survey articles available (Lane 1999 and Sarno 2000), which give one a good idea of this new modeling approach for open economies. The main characteristic of the recent literature is that the models are dynamic general equilibrium models with well-specified microfoundations. Furthermore, sticky prices and imperfect competition play a crucial role in these models.

3. DSGE METHODOLOGY

3.1. General Equilibrium

A general equilibrium is a situation for the economy as a whole where all markets are in equilibrium, with supply equaling demand at the prevailing prices. A competitive equilibrium is a special case of general equilibrium where we satisfy certain conditions.

A general equilibrium model becomes dynamic when we incorporate time. Specifically, conditions of the economy in one moment are determined in part by the past and will influence the future in some way.

A dynamic general equilibrium (DGE) model incorporates this time element using either a continuous or discrete formulation of time. Continuous time modeling is widely used in the economic growth literature, while the literature on economic fluctuations almost always uses a discrete time setup.

Each setup has its advantages. Continuous time modeling allows for the use of tools from the analysis of differential equations to solve our models. These tools are well-understood and widely used in many contexts. Discrete-time modeling requires the use of difference equations which are very similar, but are less widely used. Discrete-time modeling is very convenient when the goal is to numerically solve and or simulate a model.

3.2. DSGE Model

Dynamic stochastic general equilibrium (abbreviated DSGE or sometimes SDGE) modeling is a branch of applied general equilibrium theory that is influential in contemporary macroeconomics. The DSGE methodology attempts to explain aggregate economic phenomena, such as economic growth, business cycles, and the effects of monetary and fiscal policy, on the basis of macroeconomic models derived from microeconomic principles.

The theory of dynamic stochastic general equilibrium models (DSGE) was put by Kydland F.E., Prescott E.C. (1982), who proposed their use to study business cycles. They are based on microeconomic analysis of agents who optimize their behavior under flexible prices. Price flexibility leaves room only for real values to cause fluctuations in the economy. They may be technological shocks or sudden changes in government spending.

Later the models included elements of the Keynesian approach containing nominal rigidities. In paper of Calvo (1983), a pricing mechanism was proposed as a defined stochastic process of decision-making by firms to change the price or keeping it at the same level. Such models are called new Keynesian DSGE models. They take into account the microeconomic foundations of decision-making by households, the optimization behavior of monopolistically competitive firms and regulatory functions of the state. Due to nominal rigidities in prices and wages the required match of calculation results according to the model with real data of short-term macroeconomic fluctuations in the economy is reached.

The important advantage of models of dynamic stochastic general equilibrium is that they do not fall under the criticism of Lucas , which is applied to econometric models. For example, a commonly used method of vector autoregression and error correction models, although sometimes prove to be useful, have significant drawbacks (Kumhof M. *et al.,* 2010). They do not take into account inflation expectations, which play a crucial role in the behavior of economic agents.

DSGE models are *dynamic*. Economic agents in a DSGE world, households, firms, government institutions, formulate plans about the future. Crucially, they take into account the evolution of economic state variables, such as capital, money or wealth, so that decisions embody intertemporal trade-offs.

DSGE models are *stochastic*. They recognize the fact that economic actors operate in an environment of uncertainty, that there are foreseen and unforeseen external disturbances, and that agents take this uncertainty into account when formulating expectations about the future and setting their plans. DSGE modelling requires the specification of the stochastic environment, typically by making assumptions about the nature of the exogenous stochastic processes. In other words, dynamic stochastic general equilibrium (DSGE) models are a special class of DGE models. DSGE models incorporate at least one stochastic variable that changes over time.

Often this is a shock to productivity, but many large scale DSGE models also incorporate a large number of other types of shocks.

Since the shocks have a random component, they are modeled as stochastic processes, which are often referred to as "laws of motion." Often these laws of motion are simple stochastic processes like an AR(1) ($\log z_t = \varpi log z_{t-1} + \varepsilon_{zt} \varepsilon_{zt} \sim i.i.d. N(0;\sigma^2)\ \ 0 \leq \varpi \leq 1$) or a random walk.

Strictly speaking the shocks are the purely random innovations to the stochastic process below, however, also often use the term shock to refer to the variable upon which these innovations impact.

DSGE models also follow an *equilibrium* approach. In its most basic sense, this means that things have to add up, that budget and social resource constraints have to be obeyed, and that prices and quantities are jointly determined. Most current DSGE models specify and solve a competitive equilibrium. A competitive equilibrium is a set of allocations, $\{\Xi_j\}_{j=1}^{J}$, and prices, $\{\mathrm{p}_j\}_{j=1}^{J}$, for each factor of production and consumable such that;

i) households optimize utility,

ii) firms optimize profits,

iii) the government meets its budget constraints, and

iv) all factor and markets clear

Markets in a summarized form may include ; 1) goods market (in demand side, households consume a basket of goods based on utility maximization and in Supply side, Firms produce different goods for maximize profits under monopolistic competition), 2) labor market (in demand side, firms hire labor and in supply side, households supply labor in order to utility maximization) and 3) financial markets (households optimally invest in a one-period bond and also hold money).

4. IMPORT PRICE SETTING DYNAMIC AND PHILLIPS CURVE

4.1. Derive demand function for import

The import sector consists of monopolistically competitive firms that buy a homogenous good in the world market. Then, the imported product is turned into a differentiated good $Y_{m,j,t}$ and then sold to the perfectly competitive aggregation sector which combines the imported varieties using the production function $Y_{m,t} = \left[\int_0^1 Y_{m,j,t}^{\frac{v_{t-1}^m}{v_t^m}} dj\right]^{\frac{v_t^m}{v_t^m-1}}$.

From importing firm profit, we can derive demand fuction.

$$\max_{Y_{m,j,t}} P_{m,t} Y_{m,t} - \int_0^1 P_{m,j,t} Y_{m,j,t}$$

Subject to

$$Y_{m,t} = \left[\int_0^1 Y_{m,j,t}^{\frac{v_{t-1}^m}{v_t^m}} dj\right]^{\frac{v_t^m}{v_t^m-1}}$$

Then we have

$$\max_{Y_{m,j,t}} P_{m,t}Y_{m,t} - \int_0^1 P_{m,j,t}\,Y_{m,j,t} = \max_{Y_{m,j,t}} P_{m,t}\left[\int_0^1 Y_{m,j,t}^{\frac{v_{t-1}^m}{v_t^m}}\,dj\right]^{\frac{v_t^m}{v_t^m-1}} - \int_0^1 P_{m,j,t}\,Y_{m,j,t}$$

Take foc

$$\frac{v_t^m}{v_t^m-1}P_{m,t}\left[\int_0^1 Y_{m,j,t}^{\frac{v_{t-1}^m}{v_t^m}}\,dj\right]^{\frac{v_t^m}{v_t^m-1}-1} * \frac{v_t^m-1}{v_t^m}\,Y_{m,j,t}^{\frac{v_{t-1}^m}{v_t^m}-1} - P_{m,j,t} = 0$$

$$P_{m,t}\left[\int_0^1 Y_{m,j,t}^{\frac{v_{t-1}^m}{v_t^m}}\,dj\right]^{\frac{1}{v_t^m-1}} * Y_{m,j,t}^{\frac{-1}{v_t^m}} - P_{m,j,t} = 0$$

and because $$Y_{m,t}^{\frac{1}{v_t^m}} = \left[\int_0^1 Y_{m,j,t}^{\frac{v_{t-1}^m}{v_t^m}}\,dj\right]^{\frac{1}{v_t^m-1}}$$

Therefore

$$P_{m,t}Y_{m,t}^{\frac{1}{v_t^m}}Y_{m,j,t}^{\frac{-1}{v_t^m}} - P_{m,j,t} = 0 \rightarrow Y_{m,j,t} = \left(\frac{P_{m,j,t}}{P_{m,t}}\right)^{-v_t^m} \boldsymbol{Y_{m,t}}$$

Each importing firm j faces the following demand function

$$Y_{m,j,t} = \left(\frac{P_{m,j,t}}{P_{m,t}}\right)^{-v_t^m} \boldsymbol{Y_{m,t}}$$

4.2. Price Setting

Campa and Goldberg (2002) estimate import pass-through elasticities for a range of countries of the Organisation for Economic Co-operation and Development (OECD). They find that: (i) the degree of pass-through is partial in the short-run and becomes gradually complete only in the long-run; (ii) the sensitivity of prices to exchange rate movements is much larger at the wholesale import stage than at the consumer stage. According to the authors, one explanation for the degree of pass-through is the composition of trade in each country.

As proposed by Monacelli (2005), we assume that there is a local retailer who import differentiated goods at a cost $NEX_{t+k} * P^{f}_{t+k}$, where NEX_{t+k} refers to the nominal exchange rate, P^{f}_{t+k} is the foreign currency price of the imported good. We add the tax on import $*(1+\tau^{m}_{t,j})$. Then nominal marginal cost for the importer is $NMC_{m,t+k} = NEX_{t+k} * P^{f}_{t+k} *(1+\tau^{m}_{t,j})$

Like local producers, importing firms set prices in a staggered fashion, as in Calvo (1983). The parameter governs the degree of pass-through, generating deviations from the law of one price in the short run. Thus, the problem of the importing firm becomes:

The different importing firms buy the homogenous good at price P^{f}_{t+k} in the world market.

As in Calvo (1983) every period a fraction Ω_m of the importers firms cannot choose its price $\bar{P}_{m,j}$ optimally: The optimization program facing the importing firm that is allowed to reoptimize is

$$\max_{\tilde{p}_{m,j,t}} Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} [\, \tilde{p}_{m,j,t}\Gamma^m_{t,t+K} - NMC_{m,t+k}] Y_{m,j,t+k}, \qquad \beta, \theta_m \epsilon (0,1)$$

Subject to

$$Y_{m,i,t+k} = \left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} Y_{m,t+k} \quad \text{and } \Gamma^m_{t,t+k} = \begin{Bmatrix} 1 & \text{for } k=0 \\ \prod_{q=1}^{k} \pi^{\iota m}_{m,t+q-1} \bar{\pi}^{1-\iota_m}_m, & \iota_m \epsilon [0,1] \end{Bmatrix}$$

Rewrite the objective function

$$\rightarrow \max_{\tilde{p}_{m,j,t}} Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} (\, \tilde{p}_{m,j,t} X^m_{t,t+k} - NMC_{m,t+k}) \left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} Y_{m,t+k}$$

$$\rightarrow \max_{\tilde{p}_{m,j,t}} Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{pmatrix} \tilde{p}_{m,j,t}\Gamma^m_{t,t+K} \left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} \\ -NMC_{m,t+k} \left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} \end{pmatrix} Y_{m,t+k}$$

$$\rightarrow \max_{\tilde{p}_{m,j,t}} Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{pmatrix} \left(\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}\right)^{1-\upsilon^m_t+k} \left(\frac{1}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} \\ -NMC_{m,t+k}\left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} \end{pmatrix} Y_{m,t+k}$$

4.2.1. FOC

Take the FOC

$$Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{pmatrix} (1-\upsilon^m_t + k)\left(\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}\right)^{1-\upsilon^m_t+k} \left(\frac{1}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} \\ -NMC_{m,t+k}\left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} (\upsilon^m_{t+k}) \frac{\Gamma^m_{t,t+K}}{P_{m,t+k}} \end{pmatrix} Y_{m,t+k=0}$$

$$Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{pmatrix} (1-\upsilon^m_{t+k})\Gamma^m_{t,t+K}\left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} \\ -NMC_{m,t+k}\left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} \\ *\left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-1} \upsilon^m_{t+k}) \frac{\Gamma^m_{t,t+K}}{P_{m,t+k}} \end{pmatrix} = 0$$

$$\rightarrow Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} Y_{m,t+k}\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{bmatrix} (1-\upsilon^m_{t+k})\Gamma^m_{t,t+K} \\ -NMC_{m,t+k}\left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-1} \\ *(1-\upsilon^m_{t+k})\frac{\Gamma^m_{t,t+K}}{P_{m,t+k}} \end{bmatrix} = 0$$

$$\rightarrow Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{bmatrix} (1-\upsilon^m_{t+k})\Gamma^m_{t,t+K} \\ -\left(\frac{NMC_{m,t+k}}{\tilde{p}_{m,j,t}}\right)(-\upsilon^m_{t+k}) \end{bmatrix} \left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} Y_{m,t+k=0}$$

$$\rightarrow Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{bmatrix} (1-\upsilon^m_{t+k})\Gamma^m_{t,t+K} \\ +\left(\frac{NMC_{m,t+k}}{\tilde{p}_{m,j,t}}\right)(-\upsilon^m_{t+k}) \end{bmatrix} \left(\frac{\tilde{p}_{m,j,t}\Gamma^m_{t,t+K}}{P_{m,t+k}}\right)^{-\upsilon^m_{t+k}} Y_{m,t+k=0}$$

$$\rightarrow Et \sum_{k=0}^{\infty} (\beta\Omega_m)^k \frac{\Lambda_{t+k}/P^c_{t+k}}{\Lambda_t/P^c_t} \begin{bmatrix} (1-\upsilon^m_{t+k})\tilde{p}_{m,j,t}\Gamma^m_{t,t+K} \\ +NMC_{m,t+k}\upsilon^m_{t+k} \end{bmatrix} Y_{m,t+k=0}$$

$$\rightarrow Et\sum_{k=0}^{\infty}(\beta\Omega_m)^k\frac{\Lambda_{t+k}/P_{t+k}^c}{\Lambda_t/P_t^c}\begin{bmatrix}(1-\upsilon_{t+k}^m)\tilde{p}_{m,j,t}\Gamma_{t,t+K}^m\\ -NMC_{m,t+k}\upsilon_{t+k}^m\end{bmatrix}=0$$

$$\rightarrow Et\sum_{k=0}^{\infty}(\beta\Omega_m)^k\frac{\Lambda_{t+k}/P_{t+k}^c}{\Lambda_t/P_t^c}Y_{m,j,t+k}\begin{bmatrix}(\upsilon_{t+k}^m-1)\tilde{p}_{m,j,t}\Gamma_{t,t+K}^m\\ \upsilon_{t+k}^m NMC_{m,t+k}\end{bmatrix}=0$$

$$\rightarrow Et\sum_{k=0}^{\infty}(\beta\Omega_m)^k\frac{\Lambda_{t+k}/P_{t+k}^c}{\Lambda_t/P_t^c}Y_{m,j,t+k}((\upsilon_{t+k}^m-1)\begin{bmatrix}\tilde{p}_{m,j,t}\Gamma_{t,t+K}^m\\ -\frac{\upsilon_{t+k}^m}{(\upsilon_{t+k}^m-1)}NMC_{m,t+k}\end{bmatrix}=0$$

Since $\frac{P_t^c}{P_{t+k}^c}=\frac{1}{\prod_{q=1}^{k}\pi_{t+q}^c}$ and $NMC_{m,t+k}=NEX_{t+k}P_{t+k}^f(1+\tau_{t,j}^m)$

$$\rightarrow Et\sum_{k=0}^{\infty}(\beta\Omega_m)^k\frac{\Lambda_{t+k}}{\Lambda_t\frac{1}{\prod_{q=1}^{k}\pi_{t+q}^c}}Y_{m,j,t+k}((\upsilon_{t+k}^m-1)\begin{bmatrix}\tilde{p}_{m,j,t}\Gamma_{t,t+K}^m\\ -\frac{\upsilon_{t+k}^m}{(\upsilon_{t+k}^m-1)}NEX_{t+k}P_{t+k}^f(1+\tau_{t,j}^m)\end{bmatrix}=0$$

$$\rightarrow Et\sum_{k=0}^{\infty}(\beta\Omega_m)^k\frac{\Lambda_{t+k}}{\Lambda_t\frac{1}{\prod_{q=1}^{k}\pi_{t+q}^c}}Y_{m,j,t+k}((\upsilon_{t+k}^m-1)\begin{bmatrix}\frac{\tilde{p}_{m,j,t}\Gamma_{t,t+K}^m}{P_{m.t}}\\ -\frac{\upsilon_{t+k}^m}{(\upsilon_{t+k}^m-1)}\frac{NEX_{t+k}P_{t+k}^f(1+\tau_{t,j}^m)}{P_{m.t}}\end{bmatrix}=0$$

$$\rightarrow Et\sum_{k=0}^{\infty}(\beta\Omega_m)^k\frac{\Lambda_{t+k}}{\Lambda_t\frac{1}{\prod_{q=1}^{k}\pi_{t+q}^c}}Y_{m,j,t+k}(\upsilon_{t+k}^m-1)\begin{bmatrix}\frac{\tilde{p}_{m,j,t}\Gamma_{t,t+K}^m}{P_{m.t}}\\ -\frac{\upsilon_{t+k}^m}{(\upsilon_{t+k}^m-1)}\frac{NEX_{t+k}P_{t+k}^f(1+\tau_{t,j}^m)P_{m.t+k}}{P_{m.t}P_{m,t+k}}\end{bmatrix}=0$$

Now

$$\frac{\tilde{P}_{m,j,t}}{P_{m,t}}=\tilde{p}_{m,j,t}$$

$$\frac{P_{m.t+k}}{P_{m.t}}=\prod_{q=1}^{k}\pi_{m,t,q}$$

$$\frac{\upsilon_{t+k}^m}{(\upsilon_{t+k}^m-1)}=\mu_{t+k}^m$$

And $RealMarginalcost = \frac{NEX_{t+k}P^{f}_{t+k}(1+\tau^{m}_{t,j})}{\mathrm{P}_{\mathrm{m,t+k}}} = \mathrm{MC}_{\mathrm{m,t+k}}$

$$\rightarrow \mathrm{Et}\sum_{k=0}^{\infty}(\beta\Omega_{m})^{k}\frac{\Lambda_{t+k}}{\Lambda_{t}\prod_{q=1}^{k}\pi^{c}_{t+q}}\mathrm{Y}_{m,j,t+k}((\upsilon^{m}_{t+k}-1)\left[\begin{array}{c}\left(\prod_{q=1}^{k}\pi^{nem}_{t+q}\right)\tilde{p}_{m,j,t},\Gamma^{m}_{t,t+K}\\ -\frac{\upsilon^{m}_{t+k}}{(\upsilon^{m}_{t+k}-1)}\left(\prod_{q=1}^{k}\pi_{m,t+q}\right)\mathrm{MC}_{m,t+k}\end{array}\right]=0$$

$$\rightarrow \mathrm{Et}\sum_{k=0}^{\infty}(\beta\Omega_{m})^{k}\frac{\Lambda_{t+k}}{\Lambda_{t}\prod_{q=1}^{k}\pi^{c}_{t+q}}\left(\prod_{q=1}^{k}\pi_{m,t+q}\right)\mathrm{Y}_{m,j,t+k}(\upsilon^{m}_{t+k}-1)\left[\begin{array}{c}\tilde{p}_{m,j,t}\frac{\Gamma^{m}_{t,t+K}}{\left(\prod_{q=1}^{k}\pi_{m,t+q}\right)}\\ -\frac{\upsilon^{m}_{t+k}}{(\upsilon^{m}_{t+k}-1)}\mathrm{MC}_{m,t+k}\end{array}\right]=0$$

Divide by $Y_{m,j,t}$

$$\rightarrow \mathrm{Et}\sum_{k=0}^{\infty}(\beta\Omega_{m})^{k}\frac{\Lambda_{t+k}}{\Lambda_{t}}\left(\prod_{q=1}^{k}\frac{\pi_{m,t+q}}{\pi^{c}_{t+q}}\right)\frac{\mathrm{Y}_{m,j,t+k}}{\mathrm{Y}_{m,t}}(\upsilon^{m}_{t+k}-1)\left(\begin{array}{c}\widetilde{\mathrm{P}}_{m,j,t}\bar{\Gamma}^{m}_{t,t+k}\\ -\mu^{m}_{t+k}\mathrm{MC}_{m,t+k}\end{array}\right)=0$$

In a symmetric equilibrium

$$\rightarrow \mathrm{Et}\sum_{k=0}^{\infty}(\beta\Omega_{m})^{k}\frac{\Lambda_{t+k}}{\Lambda_{t}}\left(\prod_{q=1}^{k}\frac{\pi_{m,t+q}}{\pi^{c}_{t+q}}\right)\frac{\mathrm{Y}_{m,t+k}}{\mathrm{Y}_{m,t}}(\upsilon^{m}_{t+k}-1)\left(\begin{array}{c}\widetilde{\mathrm{P}}_{m,t}\bar{\Gamma}^{m}_{t,t+k}\\ -\mu^{m}_{t+k}\mathrm{MC}_{m,t+k}\end{array}\right)=0$$

Stationarization using $\frac{\lambda_t}{(a^{p}_{t})^{\sigma c}} = \Lambda_t \; and \; y_{m,t}a^{p}_{t} = Y_{m,t}$

$$\rightarrow \mathrm{Et}\sum_{k=0}^{\infty}(\beta\Omega_{m})^{k}\frac{\frac{\lambda_{t+k}}{(a^{p}_{t+k})^{\sigma c}}}{\frac{\lambda_{t}}{(a^{p}_{t})^{\sigma c}}}\left(\prod_{q=1}^{k}\frac{\pi_{m,t+q}}{\pi^{c}_{t+q}}\right)\frac{y_{m,t+k}a^{p}_{t+k}}{y_{m,t}a^{p}_{t}}(\upsilon^{m}_{t+k}-1)\left(\begin{array}{c}\widetilde{\mathrm{P}}_{m,t}\bar{\Gamma}^{m}_{t,t+k}\\ -\mu^{m}_{t+k}\mathrm{MC}_{m,t+k}\end{array}\right)=0$$

use $\prod_{q=1}^{k}\gamma_{t+q} = \frac{a^{p}_{t+k}}{a^{p}_{t}}$ and simplify

$$\rightarrow \mathrm{Et}\sum_{k=0}^{\infty}\left((\beta\Omega_{m})^{k}\frac{\lambda_{t+k}}{\lambda_{t}}\frac{y_{m,t+k}}{y_{m,t}}\left(\prod_{q=1}^{k}\frac{\pi_{m,t+q}\bar{\gamma}^{1-\sigma c}}{\pi^{c}_{t+q}}\right)(\upsilon^{m}_{t+k}-1\right)\left(\begin{array}{c}\widetilde{\mathrm{P}}_{m,t}\bar{\Gamma}^{m}_{t,t+k}\\ -\mu^{m}_{t+k}\mathrm{MC}_{m,t+k}\end{array}\right)=0$$

4.3. Import Price – Index

Begin with

$$P_{m,t} = [(1-\theta_m)\widetilde{\mathrm{P}}_{m,t}^{1-\upsilon_t^m} + \theta_m(\pi_{m.t-1}^{lm}\overline{\pi}_m^{1-l_m}P_{m,t-1})^{1-\upsilon_t^m}]^{\frac{1}{1-\upsilon_t^m}}$$

$$\rightarrow 1 = (1-\theta_m)\left(\frac{\widetilde{\mathrm{P}}_{\mathrm{m,t}}}{\mathrm{P}_{\mathrm{m.t}}}\right)^{1-\upsilon_t^m} + \theta_m\left(\frac{\pi_{m.t-1}^{lm}\overline{\pi}_m^{1-t_m}}{\pi_{m,t}}\right)^{1-\upsilon_t^m}$$

Define $\frac{\tilde{P}_{m,t}}{P_{m,t}} = \tilde{p}_{m,t}$

$$\rightarrow 1 = (1-\theta_m) + \widetilde{p}_{m,t}^{1-\upsilon_t^m} + \theta_m\left(\frac{\pi_{m.t-1}^{lm}\overline{\pi}_m^{1-l_m}}{\pi_{m,t}}\right)^{1-\upsilon_t^m}$$

After log – linearization process and define $\tilde{\beta}_m = \beta\frac{\overline{\pi}_m\overline{\lambda}^{1-\sigma_C}}{\overline{\pi}^c}$, Phillips curve for import sector will be obtained[1].

4.3. Import phillips Curve

The import price inflation equation is given as

$$\overline{\pi}_{m.t} = \frac{(-1\tilde{\beta}_m\theta_m)(1-\theta_m)}{(1+\tilde{\beta}_m lm)\theta_m}\left(\hat{\mu}_t^m + \widehat{MC}_{m,t}\right) + \frac{\tilde{\beta}_m}{(1+\tilde{\beta}_m lm)}E_t\hat{\pi}_{m,t+1} + \frac{l_m}{(1+\tilde{\beta}_m lm)}\hat{\pi}_{m,t-1}$$

$$\widehat{MC}_{m,t} = \widehat{NEX}_t + \hat{P}_t^f - \hat{P}_{m,t} + \zeta_m\widehat{\tau_t^m}$$

where $\zeta_m = \frac{\overline{\tau^m}}{1+\overline{\tau^m}}$

Therfore we find the dynamics of import inflation in terms of the real marginal cost and tax on import.

$$\overline{\pi}_{m.t} = \frac{(-1\tilde{\beta}_m\theta_m)(1-\theta_m)}{(1+\tilde{\beta}_m lm)\theta_m}\left(\hat{\mu}_t^m + (\widehat{NEX}_t + \hat{P}_t^f - \hat{P}_{m,t} + \frac{\overline{\tau^m}}{1+\overline{\tau^m}}\widehat{\tau_t^m})\right) + \frac{\tilde{\beta}_m}{(1+\tilde{\beta}_m lm)}E_t\hat{\pi}_{m,t+1} + \frac{l_m}{(1+\tilde{\beta}_m lm)}\hat{\pi}_{m,t-1}$$

5. CONCLUSION

Some countries, particularly developing countries, for reasons such as revenue or protect of domestic industries from foreign competition and also to create a steady demand in the home market for domestic goods imposed high import tariffs.

Considering that changes in import tax may affect supply and demand and, as a consequence, producer and consumer prices, one should expect other macroeconomic variables to be affected, such as the terms of trade and the real exchange rate.

In this study derive the Calvo (1983)-based price-setting Phillips curves for import sector, with tax on import , in a small open-economy dynamic stochastic general equilibrium (DSGE) model. On the basis of extracted import inflation dynamic, import price inflation rises as the world price of imports exceeds the local currency price of the same good. In other words, a nominal depreciation of the exchange rate or a nominal raise of the import tariff determine a wedge between the price paid by the importers in the world market and the local currency price applied in the domestic market. This wedge acts as an increase in their real marginal cost and therefore boosts foreign goods inflation. The parameter responds for price stickiness.

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