Joint PhD of the Tuscan Universities
Doctoral Program in Economics
Cycle XXXIV
Coordinator: Prof. Simone D'Alessandro
Scientific-Disciplinary Sector: SECS-P/01

Essays on Open Economy Macroeconomics

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Academic Year: 2021/2022

To my parents, Neide Ana and José Paulo,
and my brother, Rodrigo.

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Acknowledgements

I am grateful to Professor Riccardo Pariboni for his continuous support and advice. In the last two years, Riccardo has always encouraged me to cross the frontiers of my knowledge and skills.

I thank Professor Sergio Cesaratto, Professor Antonella Stirati, and Professor Ariel Dvoskin for participating in the thesis discussion. The theoretical contributions proposed in this thesis strongly rely on my academic education at the Federal University of Rio de Janeiro. I thank Professor Carlos Pinkusfeld and the professors and researchers of the Group of Political Economy.

The four chapters of this thesis have received valuable input from many scholars. I wish to thank Ariel Dvoskin and Giacomo Rella for their comments on chapters 2 and 3 during the Pontignano meetings. Professor Robert Rowthorn gave me food for thought while reviewing chapters 2 and 3. I am also grateful for suggestions from Antonella Stirati, Antonella Palumbo, Engelbert Stockhammer, Ferran Portela-Carbò, Juan Carlos Moreno Brid, Nikolas Passos, Pedro Machado, Ricardo Summa.

I wish to thank my colleagues from the 34th cycle and the whole academic community formed in the intersections of the Universities of Siena, Florence, and Pisa. Ramiro Álvarez mentored me since I decided to apply to the Ph.D. program until I finished the challenging coursework. I extend my special thanks to Francesca Fabbri for her administrative and human support. I also thank the technical staff that supports the Ph.D. program. Professor Rosa Chieza received me at the Federal University of Rio Grande do Sul for a visiting period. I gratefully acknowledge the financial support of the University of Siena.

I wish to show my appreciation to the dearest people in my life. Caroline and Hugo rescued me in hard times. Salvatore and Stella were the best company during social isolation. My friends from the Xis were present in spite of the distance. Nikolas has always been extremely supportive and generous, even when he obstinately pushes me to be a greater thinker and think greater.

I could not have completed this Ph.D. without the help of very special people who have taken care of my family in the last two years. In particular, I am enormously grateful to my aunts Ana and Cirlei, as well as to Deusa, Elacy, Elza, Manuela.

My mother has raised me with a desire for knowledge and still teaches me inspiring lessons nowadays. My father always believes in the success of my projects. I am grateful for all the support from my parents and my brother.

Introduction

Capitalist economies are open economies. Historically, capitalist economies were born as open economies. Trade and finance played fundamental role in the emergence and worldwide generalization of this economic system. From a different angle, modern capitalism is inseparable from the constitution of national states in a competitive international order, shaped by war, colonization and imperialism.

Yet, capitalist economies are often theorized as closed economies. Open economy issues are often extensions or particular cases of closed economy analyses. Economics textbooks would argue that, after all, the global economy is a closed economy, and what works for the global economy as a whole should work for its composing parts. It may not be the case that such an assumption improves our understanding of reality. On the contrary, capitalist economies may be analogous to the Möbius strip, whose non-orientable surface blurs the distinction between exterior and interior. If this is the case, macroeconomics should not study closed and open economy issues separately. Rather, macroeconomics should be studied primarily from an open economy perspective.

I take this premise seriously in this thesis. I discuss inflation, growth, and distribution with special attention to exchange rate, trade, and external finance. These topics are approached with theoretical and empirical methods. Theoretical inquiry pays attention to the history of ideas to discuss modern economic models. The theoretical research in this thesis also develops economic models and simulations. Empirical methods rely on state of-art time series econometrics techniques.

In the course of this thesis, I adress open economy macroeconomic theory and policy from a Classical-Keynesian perspective. The theoretical and empirical ideas presented in the next pages are therefore in line with two fundamental notions: the Classical theory of distribution and the Principle of Effective Demand.

The classical theory of value and distribution determines relative prices and income distribution in the same system of long period price equations. Classical theory emphasizes institutional and political factors in explaining distribution. Alternative distributive closures explore such causes in ways that are coherent with the classical analytical method. There is no rigid relation between the theory of output and the theory of value in this approach. Rather, the Classical theory analytically distinguishes the theory of value and distribution from the theory of output and accumulation. Therefore, it is possible speak of a Classical-Keynesian approach, in which classical approach to distribution can be integrated with a Keynesian view on output and accumulation. A Classical-Keynesian perspective considers that demand determines the output level according to the Principle of Effective Demand, as proposed by Keynes and Kalecki. In the long period, in which productive capacity changes, demand also drives output growth and capital accumulation. As productive capacity adjusts to effective demand, an independent level of investment determines savings also in the long run.

While open economy concerns matter for macroeconomics as a whole, this thesis focus on economic concerns of peripheral economies. The division between core and peripheral economies was a fundamental premise in the Latin American Structuralist School. Peripheral economies were included in the international division of labor through its relation with core economies, thereby becoming a constitutive element of the global economy. The peripheral condition meant that the external sector provided the main source of dynamism for these economies, but also imposed crucial constraints to growth and development.

Structuralist scholars showed that domestic prices and distribution in peripheral economies were directly affected by events in the international markets. They realized that movements in international prices affected the way peripheral countries disputed their share of surplus with other countries. In a closed economy, the Classical theory of value can explain both relative prices and distribution among social classes. In an open economy setup, relative prices are also associated with the distribution of the surplus among nations. The declining trend of the terms of trade of peripheral economies identified in the post-war thus had fundamental implications for peripheral economies. As a relative price itself, exchange rates also affects the distribution of the surplus across nations. As we will discuss, this effects have crucial implications for distributive conflict and inflation in peripheral economies.

Owing to their vulnerability to international shocks, peripheral economies were particularly affected by the COVID-19 pandemic crisis. The outbreak of COVID-19 engendered the deepest recession of the last decades. Social distancing measures shut down economic activities to slow the spread of the disease. The supply shock in these activities resulted in a sharp fall in output and employment. The rise in unemployment, and the fear related to the consumption of goods and services involving higher risk of contagion reduced consumers' spending. This combination of supply and demand shocks caused a crisis of global dimensions.

After two years, economic recovery still faces important challenges in advanced and developing economies. Such challenges are directly related to the impact of international variables on inflation and distribution, trade and growth, debt and financial stability. I address these topics in this thesis, hoping that it provides a small contribution to the understanding of the current situation. The thesis is structured in four chapters.

The first essay reviews conflict inflation models, contrasting alternative theoretical perspectives underlying conflicting claims models. Conflicting claims models have stressed the race between prices and money wages, in the struggle among capitalists and workers, as the main inflationary pressure. The essay shows how these models describe conflict inflation and the related outcome for income distribution. The chapter also explores criticism to the New-Keynesian Phillips curve and the relation between inflation and endogenous money theory. A deeper understanding of distributive conflict requires an analytical exposition of the relation between prices and distribution. In general, conflicting claims models rely on Kaleckian explanation of distribution, based on the notion of mark-up pricing according to the degree of monopoly. Conflict inflation allows wage bargaining to affect income distribution and, thus, the real mark-up level. However, this theory contains unsolved theoretical shortcomings, lacking an ultimate explanation for profits and overlooking input-output relations. An alternative theory of distribution can be found in modern appraisals of the Classical surplus approach, which has been extended to the study of inflation, providing a consistent relation between inflation and conflict.

The second essay develops a conflicting claims models for a price-taker open economy. We start from the view that the evolution of prices and income distribution in open economies cannot be studied independently from international prices and exchange rates, especially in small open economies. Exchange rates and international prices are thus fundamental to explaining inflation in open economies. Conflict inflation models usually account for these variables by including imported inputs and, in some cases, a distributive impact of exchange rates. A different viewpoint emerges from the

Classical-Keynesian distribution theory for a price-taker open economy. Thus, we explore this alternative by developing a conflict inflation model along the lines of the Classical-Keynesian approach. The chapter contributes to the literature by combining the conflicting claims approach with the Classical-Keynesian open economy framework. Including tradable prices, the model considers their direct impact on distribution. Therefore, it addresses a cause of inflation overlooked in the literature. Finally, conflict inflation affects the real exchange rate, which becomes an important distributive variable.

The third essay assesses the connection between global and domestic inflation in Brazil during the period from 1999 to 2020. Input-output linkages have been shown to be an important transmission channel of inflation synchronization of inflation for advanced and emerging economies. International cost shocks have been less studied in the case of Brazil. We therefore estimate a Structural VAR model with an index for producer prices (PPI) of Brazilian trade partners, in addition to the other relevant determinants of inflation. The Foreign PPI index is weighted by the yearly average share of each country in Brazilian imports of intermediate and capital goods. Estimates shows a positive effect of Foreign PPI index on Brazilian Consumer Price Index, constituting a relevant explanation for domestic inflation in Brazil during the period 1999-2020. Impulse Response functions show that the Exchange Rate is the main determinant of domestic CPI in Brazil. International prices and exchange rate have fundamental implications for the operation of the inflation targeting regime. The results are in line with the literature's empirical findings showing the overall relevance of international variables in the explanation of inflation. Further research may discuss the transmission channels of cross border inflation as well as evaluate the implications of these results to inflation theory.

The fourth essay extends the baseline Sraffian supermultiplier model for an open economy with government, introducing two autonomous expenditures. The two sources of autonomous demand correspond to public expenditures and exports. We also analyze the stability conditions for public debt and foreign debt ratios. Public debt stability requires that the interest rate on public debt is smaller than the output growth rate, as in Domar (1944). Foreign debt is evaluated in proportion to exports, accounting for the availability of foreign currency required to service external liabilities. The foreign debt-to-exports ratio converges to a stable value when the international interest rate is smaller than the growth rate of exports. However, this value may not be compatible with the availability of international capital flows. We examine the consequences of a constraint to foreign debt ratio, in line with Bhering et al. (2019), reiterating the importance of a long-term external constraint to economic growth (Thirlwall, 1979). A fiscal policy rule is proposed to keep the foreign debt ratio below an upper limit for this ratio. We simulate five experiments showing the conditions for stability of debt ratios, the execution of the fiscal policy rule, and the alternative of a structural change policy. Altogether, the chapter provides stability conditions for growth in an open economy paying its international liabilities in foreign currency. Simulations show the fiscal policy successfully reduces the equilibrium foreign debt-to-exports ratio by decreasing the share of public expenditures in autonomous demand. Experiments also show that industrial policies that cause structural change and increase exports' growth keep the foreign debt ratio below the threshold with a better growth performance than the fiscal policy rule.

Chapter 1

Inflation and Distributive Conflict

1.1 Conflict inflation

The regular coexistence of price level increases with labor unemployment and spare capacity is a stylized fact supporting cost-push interpretations of inflation. This view contrasts with the dominant theory of inflation, according to which inflation accelerates (decelerate) when aggregate demand exceeds (falls behind) potential output. The fact that aggregate demand is often below potential output suggests that inflation causes are found in cost shocks.

To analyze the effect of costs on inflation, we must remember that costs consist basically of wages, profit rate, rent, and inputs costs. Inputs are priced according to their own production costs, which, in turn, also depend on the compensations of labor, capital, and land, and input prices. Repeating this process, we conclude that production costs can be decomposed into the basic distributive variables that reward the social groups involved in producing the economy's output. The income generated in production is primarily distributed as wages, rewarding the provision of labor, profits for the anticipation of capital, and rent, compensating the hire of scarce and privately-owned resources. After that, these compensations are partially redistributed in the form of taxes, interest, and transfers, whose value depends on tax rates, interest rate, exchange rate, and international prices. In a monetary economy, distributive variables are set in nominal terms. Altogether, they determine relative prices, the price level, and distributive outcomes (Bastos, 2010).

At this point, the conflict between social groups comes into play in the determination of inflation. Given productive techniques, a rise in prices can be traced back to the increase in at least one of the distributive variables.[1] Indeed, inflation arises when social groups successfully ask for nominal increases, making the price level no longer compatible with the set of distributive variables. By means of nominal increases, classes seek an increase in real terms (which implies a larger income share). When workers obtain wage increases through bargaining, capitalists try to protect their profits, passing higher unit labor costs on to prices. A higher cost of living leads to further wage demands in a process that may be repeated many times. Along these lines, we can argue that inflation is a consequence of distributive conflict (as Okishio 1977, Rowthorn 1977, Stirati 2001, Lavoie, 2014, p. 541-573).[2] In this case, the *real* outcome for distributive variables is only known at the end of each period, as changes in their nominal value affect the price level and relative prices (Pivetti, 1991; Serrano, 1993).

Structuralist authors underlined that production bottlenecks could cause inflation (Noyola Vázquez, 1956; Pérez Caldentey, 2019; Sunkel, 1958). We can frame a similar argument as follows. In a growing economy, production in certain sectors can approach full capacity within the cost-minimizing technique before other sectors. Additional production may be carried out with a less productive technique to attend demand in these sectors. For example, production may employ a technique requiring a higher input of labor per unit of output. When this happens, relative prices will change. The point here is that such adjustments of relative prices can lead to inflation, even when nominal distributive variables are not the original cause of price rise. However, after the price increase, social groups tend to react by asking for increases in their compensations to preserve their purchasing power. Thus, the inflationary propagation of original shocks through income claims is another manifestation of conflict inflation.[3]

Conflicting claims models have stressed the race between prices and money wages, in the struggle among capitalists and workers as the main inflationary pressure. "Therefore, roughly speaking, inflation comes about when the capitalist classes are not strong enough to depress the real wage rate without proceeding to raise prices and the labouring classes are not strong enough to win a higher real wage rate at the sacrifice of profits, preventing

[1] In the case of an open economy, the rise in prices can be caused by the rise in the international price of inputs or tradable goods. However, an increase in these prices is caused by an increase in foreign distributive variables in the first place. In the next section, we discuss the open economy case in more detail.

[2] See also Dutt (1987) Dalziel (1990), Setterfield (2007), Serrano (2010).

[3] Historically, a common argument against cost-push explanations of inflation is that relative price adjustments do not necessarily cause inflation. However, these adjustments tend to be inflationary because otherwise, they would require that while some prices and incomes nominally increase, others decrease. Social groups reject nominal decreases to avoid real losses. Money wages are rigid downwards, and capitalists will not give up on profits if not compelled by competition.

the capitalist classes from raising prices" (Okishio, 1977).

Although the relation between inflation and distributive conflict can be found in previous economic literature,[4] Rowthorn's (1977) contribution is acknowledged as the foundation of conflict claims modeling. Inspired in the original Phillips curve and in the Marxian notion of reserve army of labor, Rowthorn explicitly introduced the unemployment rate among the determinants of workers' wage claims. The stylized fact that lower unemployment correlates with a higher rate of change in money wages (Phillips, 1958) is consistent with the fact that when unemployment is low, workers experience higher bargaining power in wage negotiations.[5] Meanwhile, when unemployment is high, workers fear losing their jobs and face lower bargaining power. Hence, the rate of change of money wages may depend more on the bargaining conditions than on workers' aspirations. Indeed, "[w]orkers may feel that the real wage is much too low compared to what they consider to be the just rate, but they may have few means to implement their beliefs" (Lavoie, 2014, p. 550). Apart from labor market conditions, institutional and political factors affect workers' bargaining position, such as labor laws, strength of unions and employer's associations, social rights,[6] and political representation of class interests.[7]

While on the one side, fear of unemployment discourages wage claims, on the other, competition imposes boundaries to price increases. If capitalists were able to *immediately* and *completely* pass through changes in their costs into prices, workers' effort to rise real wages would be vain. In this case, an increase in money wages would immediately imply a proportional rise in prices. Real wages would remain unchanged in this process (Tarling and Wilkinson, 1985).

Before a deeper discussion on conflicting claims models, let us briefly review two relevant matters for inflation theory. In the next section, we discuss endogenous money theory, a theoretical development in macroeconomics which is fundamental to the understanding of inflation. Endogenous money theory rejects the traditional

4 As in Robinson (1938), Aujac (1954), Okishio (1977), Furtado (1954, 1963) and Noyola Vázquez (1956). See also Morlin (2021) for a review on the debate in the US in the post-war period.

5 Indeed, despite later neoclassical reinterpretations of the Phillips curve, the original work of Phillips proposed an explanation of the rate of change of wages based on an interplay between market and institutional variables, compatible with the role played by bargaining power in determining wages (Forder, 2014).

6 According to Esping-Andersen (1990, p.11), "the balance of class power is fundamentally altered when workers enjoy social rights, for the social wage lessens the worker's dependence on the market and employers, and thus turns into a potential power resource".

7 Korpi (2002) and Kristal (2010) provide evidence on the impact of workers' political representations on the wage share.

explanation of inflation according to exogenous changes in the quantity of money. However, it is still compatible with a demand-pull theory of inflation, as in the New-Keynesian Phillips curve. We therefore dedicate another section to discuss the New-Keynesian approach to inflation theory, which considers excess demand as the most relevant determinant of inflation rather than supply shocks or the distributive struggle. The section also revisits the main critiques against this view, contrasting it with the perspective of conflict inflation.

1.2 Endogenous money

Conflict inflation theories contend that prices change autonomously from movements in money supply, relying on some passive adjustment of the money supply to the price rise. Endogenous money theory, as defended by modern post-Keynesian approaches, points that the quantity of money supply is determined by the demand for money, which, in turn, depends on output and the price level (Lavoie, 2014; Wray et al., 1998). Accordingly, the growth of money aggregates is determined by inflation and output growth. This framework builds on early contributions of Kaldor (1985) and Moore (1988a,b). Opposing the monetarist view of the exogenous supply of money, Kaldor emphasizes a broad definition of the monetary base in terms of the high liquidity of many financial assets, discussing the money creation by banks through credit. The author argues that the money supply is determined by the demand for money, given the level of income and the interest rate set by the monetary authority (Kaldor, 1985). This criticism also stressed that central banks are unable to control the money supply. What monetary policy actually determines, according to this view, is the basic interest rate of the economy. Indeed, Moore (1988a, p. 381) states, "[m]onetary endogeneity implies that central banks do not exogenously determine the quantity of credit money in existence, but rather the price at which it is supplied, that is, the short-term interest rate. The money supply is endogenously determined by market forces."

The notion that money supply is endogenous is widespread in modern macroeconomic theory, currently accepted by post-Keynesian and New-Keynesian approaches. Indeed, this view is also compatible with the operation of Central Banks. According to McLeay et al. (2014, p. 21), "[t]he supply of both reserves and currency (which together make up base money) is determined by banks' demand for reserves both for the settlement of payments and to meet demand for currency from their customers — demand that the central bank typically accommodates". In turn, commercial banks' regular operations create and destroy money. In particular, banks create new money supply, in the form of deposits, when lending to borrowers. The decision to make a new loan usually depends on the existence of profitable lending opportunities. The availability of reserves does not constrain this process. However, the requirement of profitability of banks facing a competitive market, the regulatory policy constraint to preserve financial stability, and banks' restriction to lend due to mitigation of risks may constraint the supply of new loans (McLeay et al., 2014). In other words, the demand for credit drives bank loans. Banks are willing to lend money whenever borrowers are believed to be able to honor their commitments.

The direction of causality between money supply and the price level has long been the object of controversy in economic theory. Arguments supporting the endogeneity of money supply appeared together with cost-push inflation theory in James Steuart and Thomas Tooke (Smith, 2011; Yang, 1999). We can discuss this point in the light of the equation of exchange (see 1.1), according to Green (1992, p. 14) " a common point of reference for all approaches to the problem of inflation since the relationships it expresses simply constitute a truism and do not in themselves imply causality".

$$M^S V = PQ \qquad [1.1]$$

Suppose the evolution of costs determines both the price level (P) and inflation. In that case, for a given level of real output (Q), movements in prices must be compensated by changes in money supply (the left-hand side of equation 1.1). Note that, here, money supply consists of the product of the nominal amount of money in circulation and the velocity of circulation (*i.e.*, the frequency in which a unit of currency is traded). If the output level (Q) is determined elsewhere and does not directly relate to prices, positive inflation implies growth in $M^S V$. In this regard, we emphasize that classical political economy did not establish a direct relation between output and prices, rather keeping an analytical distinction of the theory of value — determining prices and distribution — on the one hand, and the theory of output and accumulation on the other (Garegnani, 1984). Thus, a separate determination of output and prices support this argument. In terms of post-Keynesian approaches, output level and growth are determined by effective demand level and growth, while costs determine the price level and inflation.

Contrasting with the previous exposition is the Quantitative Theory of Money, which was formulated in different terms over the history of economics. In a simple appraisal, quantitative theory contents that changes in the money supply determine the inflation rate. Thus, this means that in the equation 1.2, the left-hand side is exogenous and determines the right-hand side. Its original formulation reflected an extension of the analysis of the determination of commodity prices through the interaction between supply and demand, as in mercantilist analysis. Thus, money itself — in the form of gold or silver — was also a commodity. Hence, an inflow of metal in a specific country depreciated the metal's value, increasing the general price of all other commodities with respect to metal (Green, 1992, p. 27-28). Proponents of the quantity theory assumed that both output and velocity of circulation are stable. For this reason, an exogenous increase in m could only cause inflation.[8] The stability of V may be due to the fact that institutional factors shaping the time periodicity of transactions tend to change slowly (Snowdon and Vane, 2005, p. 50-53). As a result, nominal variables are affected by changes in money supply, while real variables, as income, remain stable. In this case, money is neutral, and inflation consists strictly of a monetary phenomenon lacking any influence from real causes.

$$\hat{m}^s + \hat{v} = \pi + g \qquad [1.2]$$

Finally, as pointed previously, the New-Keynesian approach accepts the notion of endogenous money. In this view, inflation arises due to a short-term real disequilibrium caused by an excess of demand with respect to natural output (Pérez Caldentey, 2019, p. 128). In turn, excess demand results from a divergence between the interest rate and the natural interest rate — *i.e.*, the one that brings aggregate supply and demand into equilibrium. Thus, this explanation of inflation contrasts with the distributive conflict perspective.

The last paragraphs show that the widely acknowledged endogeneity of money dismisses explanations of inflation based on changes in the money supply, as in the Quantitative Theory of Money. However, adopting an endogenous money perspective does not necessarily mean endorsing a conflict inflation view. Indeed, a demand-pull inflation theory is consistent with endogenous money supply in the New Keynesian approach. This theory is further explored in the following paragraphs.

[8] Still, Green (1992) caveats that some authors allowed for a short-run nonprice effect of a metal inflow.

1.3 Demand-pull inflation in New Keynesian economics

The New-Keynesian Phillips Curve describes how past inflation, expected future inflation and aggregate demand drive the current inflation rate. According to Woodford (2003), modern mainstream approach to inflation recalls a "Wicksellian flavor". Wicksell (1898b) states that inflation arises from the discrepancy between the money interest rate (prevailing in the loans market) and the natural interest rate, which is defined as the rate at which the supply of savings is equal to the demand for loans. Wicksell stresses that banks accommodate additional demand for loans without raising the interest rate in a pure credit economy. The author, thus, introduces a notion of endogenous money. When the money interest rate remains below the natural rate, "entrepreneurs will in the first instance obtain a surplus profit (at the cost of the capitalists) over and above their real entrepreneur profit or wage" (Wicksell, 1898b, p. 127). Hence, the return on real investment net of interest remains higher than when the interest rate equals the natural rate. In turn, this pushes the expansion of production through investment, raising the demand for raw materials, and capital goods, causing the rise of prices of commodities. An inflationary process emerges, persisting until the banking system corrects the discrepancy between money and natural rates. Symmetric reasoning describes the case in which the money rate is above the natural rate, causing a cumulative deflation (Wicksell, 1898a,b).[9]

Likewise, the New Keynesian view posits the existence of a natural interest rate under which the rate of inflation is stable. Nevertheless, we must point out a difference between the two perspectives. While the natural interest rate ensured the stability of the price level in Wicksell, it ensures the stability of the inflation rate in the New Keynesian view. Inflation expectations explain the stability of inflation around a trend in New Keynesian Phillips Curve. This conclusion is obtained when the coefficient of expected inflation in the Phillips curve is equal to one. In some models, this result requires a complete effect of the past inflation on current inflation through the change in inflation expectations. In this case, increases in inflation rate in the past are fully included in agents' current expectations. In a hybrid New Keynesian Phillips Curve — as proposed in Galı and Gertler (1999) — both past inflation and forward-looking expectations affect current inflation. Then, the combined effect of past and expected inflation should be

[9] A relevant feature of this approach is money neutrality, found in the inability of the money interest rate in influencing the natural interest rate. As pointed before, the money interest rate converges towards the natural interest rate in the long term. Hence, the latter is ultimately determined by real rather than monetary factors. See also Garegnani (1979) and Pivetti (2001).

complete, *i.e.*, the sum of the coefficients of past inflation and expected inflation must be equal to one. In both cases, this hypothesis allows new-Keynesians to reject the trade-off between inflation and unemployment in the long term, advocating in favor of the existence of a natural rate of unemployment (see, for instance, Gordon 2011). The unemployment rate consistent with stable inflation is labeled as the Non-Accelerating Inflation Rate of Unemployment (NAIRU). In the long run, the determination of real values of equilibrium output and unemployment is unaffected by the inflation rate.

According to the New Keynesian approach, when the interest rate set by the monetary authority differs from the natural interest rate, actual output diverges from the potential output determined by supply-side conditions. Thus, an interest rate higher than the natural rate generates an excess of aggregate demand. Alternatively, if the interest rate is lower than the natural, output remains below potential output, causing the decrease in inflation rate (Woodford, 2003). In sum, in this approach, "the natural real rate of interest is the rate associated with the absence of the nominal rigidities that account for short-run monetary nonneutralities, and the gap between the actual interest rate and the natural real rate represents the key channel through which central bank actions affect the economy" (Walsh, 2005, p. 464).

Considering this, New-Keynesian economists focused on formulating monetary policy rules to stabilize inflation, as, for instance, the inflation targeting policy (Taylor, 1999). Monetary policy is executed by Central Banks and centers on pegging the basic interest rate to stabilize inflation. According to this view, stabilizing inflation is equivalent to stabilizing the output gap. Thus, monetary policy should concentrate efforts on the first goal. This property has been labeled as the 'divine coincidence' and implies no trade-off between stabilizing inflation and the output gap (Blanchard and Galí, 2007).

Even though an excess of demand is generally considered the cause of inflation acceleration, cost shocks also cause inflation in New-Keynesian models. Asymmetric cost shocks under nominal rigidity of prices and wages can accelerate inflation while relative prices adjust to the change in relative costs (Ball and Mankiw, 1994). An obvious example is the oil-shocks of the 1970s (Gordon, 1984). Moreover, Ravenna and Walsh (2006) argue that monetary policy shocks can temporarily raise inflation due to the effect of the nominal rate of interest on the marginal cost of firms — effect known as the cost-channel. Nevertheless, cost increases consist only of a temporary cause of inflation. In the long term, inflation is solely caused by the excess of demand, since, in this time horizon, the nominal rigidity of prices and wage is absent, and cost shocks are assumed to have zero mean (Carlin and Soskice, 2014). As shown by Serrano (2019), dropping the zero mean assumption is enough to ensure the existence of cost-push inflation in the New Keynesian Phillips Curve, even in the long term.

An alternative explanation for the absence of cost-push inflation in the long term lies in the effort of reconciling the New Keynesian Phillips Curve with the general equilibrium analysis. In this case, relative prices and income distribution are assumed to converge to general equilibrium positions (Woodford, 2003). Moreover, the economy converges towards the natural output and the natural interest rate, which result from the real equilibrium obtained without the nominal rigidity. Relative prices, wages, and profit rates converge to real equilibrium levels compatible with supply and demand schedules at the microeconomic level. In equilibrium, relative prices match supply and demand, and income distribution depends on factors' marginal productivity. In this case, the underlying logic of conflict inflation theory cannot operate since it requires that social groups can persistently shift income distribution through changes in their nominal compensations.

Therefore, even though some New-Keynesian scholars aim to introduce conflict inflation within this theoretical framework (as, for instance, Carlin and Soskice, 2014), conflict can only be assigned a transient role and cannot be consistently taken as the main cause of inflation. In contrast, conflict inflation theory rejects that relative prices and income distribution are determined according to supply and demand schedules, as in general equilibrium theory. Rather, conflict inflation admits that nominal shocks can persistently affect distribution. Distributive variables do not converge to a predetermined equilibrium value in this view. In fact, they may remain persistently different after a nominal shock. If this is the case, cost-shocks tend to be positive on average, so that costs can be considered a recurrent cause of inflation (Serrano, 2019).

Critics have raised many arguments against the New-Keynesian theory of inflation. First, it relies on the notion of a natural interest rate. In other words, New Keynesians assume that there is a single value for the real interest rate that equalizes investment and full employment savings. The negative interest-elasticity of investment must be founded on the labor-capital substitution mechanism along the lines of the neoclassical approach (Petri, 2015, p. 316). Thus, the investment curve needs to be derived from a persistent demand for capital, conceived as a single factor (value-capital, rather than a set of capital goods). Nevertheless, neoclassical labor-capital substitution must be rejected in the light of the Cambridge controversy in capital theory (Garegnani, 1978; Lazzarini, 2011; Petri, 2019). The idea that "the proportions in which factors are employed vary with the prices of their services" requires that the quantity of factors are defined independently from the relative prices (Garegnani, 1978, p. 349). But this is not the case for the 'single factor' capital, which is measured according to the value of the capital goods. In addition, the possibility of reverse capital deepening shows that the value of capital per worker may increase when the interest rate increases. In conclusion, the Cambridge controversy makes it very difficult to rely on the negative interest-elasticity of investment. Finally, Petri (2015) argues that even if we concede negative interest-elasticity, neoclassical theory cannot determine the flow of investment in each period without assuming full-employment of labor to hold continuously, which is unreasonable.

Critics have also contested assumptions and results of the New-Keynesian Phillips Curve from an empirical perspective.[10] Smithin (2004) criticized the arbitrariness of estimates of the value of the natural interest rate. Furthermore, evidence of hysteresis in the unemployment rate challenges the notion of NAIRU (Stanley, 2004, 2013). Hysteresis means that persistent deviations from equilibrium position affect the equilibrium itself. Hysteresis appears in unemployment in the form of a non-stationary unemployment rate. Hence, there is not a long-term value towards which the unemployment rate converges. Critics also find evidence supporting the view that demand shocks have a persistent impact on unemployment (Storm and Naastepad, 2009). Further empirical findings support the rejection of the accelerationist Phillips curve present in the New-Keynesian models, suggesting the existence of a long-term trade-off between inflation and unemployment (Stirati and Paternesi Meloni, 2018; Summa and Braga, 2020).[11] These results also challenge important conclusions of the New-Keynesian theory as the long-term neutrality of monetary policy. Finally, recent criticism has focused on the inability of the New-Keynesian Phillips Curve in explaining the contemporary economic events of the so-called Secular Stagnation (Serrano et al., 2020).

[10] Serrano (2019) provides an assessment of the New-Keynesian Phillips Curve under the relaxation of its assumptions. By these means, he shows that relaxing the assumption of full inflationary inertia (or, in the hybrid models, a complete combined effect of past and expected inflation over current inflation) is enough to dismiss important conclusions of this approach as the no permanent trade-off between inflation and unemployment.

[11] Such findings have also been acknowledged by supporters of the New-Keynesian approach, as Blanchard (2016); Blanchard et al. (2015); Gordon (2018).

1.4 Kaleckian conflicting claims models

A deeper understanding of conflict inflation requires introducing an analytical exposition of the relation between prices and distribution. For this reason, we present how this approach describes conflict inflation, mainly based on the exposition of Lavoie (2014), adapting the notation. Lavoie (2014) departs from the decomposition of aggregate income into wages and average mark-up, as proposed by Weintraub (1978). By definition, aggregate income (Y) is equal to aggregate output in a closed economy. From this identity, follows the equation below, where output is measured as the product between real net output (Q) and the price level (P_t).

$$P_t Q_t = Y_t \qquad [1.3]$$

Furthermore, aggregate income can be decomposed into the wage bill (W) plus aggregate profit. Weintraub (1978, p.45) also takes the total profits as equal to an average mark-up on labor costs (μ_t), as presented below.

$$P_t Q_t = W_t(1 + \mu_t) \qquad [1.4]$$

In addition, the wage bill can be written as the product between the number of workers and the average wage rate (w), which gives us the following equation:

$$P_t Q_t = w_t L_t(1 + \mu_t) \qquad [1.5]$$

Finally, dividing both sides of equation 1.5 per Q_t, we obtain the equation 1.6.

$$P_t = w_t l_t(1 + \mu_t) \qquad [1.6]$$

Here, l stands for the labor-output ratio of this economy and is inversely related to labor productivity. Moreover, the term $(1 + \mu_t)$ expresses the ratio of prices to money wages. Rearranging equation 1.6, we find a correspondence between the mark-up and the real wage rate, shown in equation 1.7. Given productivity, a higher mark-up implies a lower real wage.

$$\frac{1}{(1+\mu_t)} = \frac{w_t l_t}{P_t} = \omega_t l_t \qquad [1.7]$$

The product between the real wage (ω_t) and the labor-output ratio (l_t) also expresses the wage-share in this economy. A simple operation in equation 1.5 shows that this term corresponds to the ratio between the wage bill and the nominal output ($\frac{w_t L_t}{P_t Q_t}$), which represents the wage-share in this economy. Moreover, it follows that the wage-share can be written as $\frac{1}{(1+\mu_t)}$. Conversely, the profit share is given by:

$$\frac{P_t Q_t - w_t L_t}{P_t Q_t} = \omega_t l_t \mu_t \qquad [1.8]$$

Since the total income is given by $w_t L_t (1+\mu_t)$, it follows that the profit share also corresponds to $\frac{w_t L_t \mu_t}{w_t L_t (1+\mu_t)}$, which can be expressed as $\frac{\mu_t}{(1+\mu_t)}$. Therefore, whatever determines the mark-up regulates the functional income distribution under stable prices (Cassetti, 2002; Lavoie, 2014).

In the Kaleckian view, firms set prices by adding a mark-up on unit production costs. The mark-up depends solely on the degree of monopoly found in the respective market (Kalecki, 1954). Hence, the aggregation of the mark-ups found in the economy determines income distribution between workers and capitalists. In other words, the average mark-up of the economy is determined by the market power of firms observed in different markets. As a consequence, workers would not be able to change distribution through wage negotiations. However, Kalecki (1971) eventually admitted that strong labor activism could impose wage increases that would not be passed through prices, reducing firms' mark-up.

Taking growth rates from equation 1.6, we can derive an interpretation of the causes of inflation (Lavoie, 2014; Weintraub, 1978). Thus, inflation (π) is written as the sum of the rate of change of money wages, rate of change labor-output ratio (so that productivity growth reduces inflation), and the rate of change of the ratio of prices to money wages (caused by changes in the average mark-up)[12], all for the same period.

[12] Note that the rate of change of $(1+\mu_t)$ can be rewritten in terms of the change in the average mark-up.

$$(1 \hat{+} \mu_t) = \frac{\dot{\mu_t}}{(1+\mu_t)}$$

$$\hat{\pi}_t = \hat{w}_t + \hat{l}_t + (1 \hat{+} \mu_t) \qquad [1.9]$$

Although the market structure determines the baseline mark-up, the mark-up's real value may change in conflicting claims models. By introducing bargaining power of workers and capitalists, authors[13] aim to address the possibility mentioned by Kalecki (1971) that strong unions may compress firm's mark-ups. Following Lavoie (2014), we can set the general features of these conflicting claims models. First, we assume, for the sake of simplification, that productivity is constant ($\hat{l} = 0$). Hence, the dynamics of inflation is dominated by movements in wages and mark-ups (see equation 1.9). Moreover, wages negotiated between workers and firms are regulated by the bargaining power of workers (Ω_1), the degree of formal and informal wage indexation (Ω_2), past inflation rate (π_{t-1}), and the aspiration gap — as shown in equation 1.10. Indexation and past inflation affect wages because workers seek to recover wages' purchasing power after price increases. In general, models assume indexation is incomplete — *i.e.* Ω_2 is less than one. In turn, the aspiration gap corresponds to the difference between worker's targeted real wage (ω_w) and the actual real wage (ω_t).

$$\hat{w}_t = \Omega_1(\omega_w - \omega_{t-1}) + \Omega_2 \pi_{t-1} \qquad [1.10]$$

Firms increase prices to keep the mark-up close to the desired mark-up. As shown above, there is an inverse relationship between the mark-up and the real wage for a given technology. Thus, the firm's desired mark-up can be expressed in terms of a targeted real wage (ω_f). The difference between the actual real wage and the targeted real wage defines firm's aspiration gap (Lavoie, 2014). Whenever the gap is positive, firms raise prices to an extent that also depends on the bargaining power of firms (ψ_1). Furthermore, firms pass through unit labor cost increase — which, in the absence of productivity changes, corresponds to wage increases — into prices, in a degree determined by the price indexation factor (ψ_2). Equation 1.11 summarizes these relations.

where $\dot{\mu}_t$ stands for the derivative of μ_t with respect to time (or the change in time, in the discrete case).

[13] See, for instance, Cassetti (2002), Lavoie (2014)

$$\pi_t = \psi_1(\omega_t - \omega_f) + \psi_2\hat{w}_t \quad [1.11]$$

In this model, equilibrium real wage and inflation rate are achieved when prices and wages rise at the same rate, stabilizing income distribution. The following expressions describe the equilibrium.

$$\omega^* = \frac{\Omega_1(1-\psi_2)\omega_w + \psi_1(1-\Omega_2)\omega_f}{\Omega_1(1-\psi_2) + \psi_1(1-\Omega_2)} \quad [1.12]$$

$$\pi^* = \frac{\psi_1\Omega_1(\omega_w - \omega_f)}{\Omega_1(1-\psi_2) + \psi_1(1-\Omega_2)} \quad [1.13]$$

In general, firms can only partially index prices to costs, and workers can only partially index wages to the cost of living. Besides, both sides present limited bargaining power, which implies that equilibrium real wage lies within the real wage targets of workers and firms. In this general case, neither side achieves its desired outcome (Dalziel, 1990; Lavoie, 2014). Thus, the equilibrium real wage is a weighted average of workers' and firms' real wage target. It increases with the bargaining power of workers and with wage indexation. It decreases with the bargaining power of firms and the speed of price adjustment after wage increases. Whatever increases the equilibrium real wage decreases the equilibrium level of the mark-up. Therefore, the baseline mark-up determined by the firm's market power is allowed to change due to inflation. Mark-up varies according to the relative bargaining power of workers and capitalists, the speed of adjustment of prices to wage increases, and the speed at which wage claims react to price increases.

The equilibrium inflation rate depends on the relative bargaining power of both workers and firms. The higher the bargaining power of workers, the higher the inflation rate and the real wage rate. Conversely, a higher bargaining power in firm's side generates a combination of higher inflation – since firms raise prices more quickly – and lower equilibrium real wage. Moreover, a greater discrepancy between real wage targeted by workers and firms, that is, a greater degree of conflict between workers' and firms' income claims, leads to a higher rate of inflation (Lavoie, 2014)

A particular case of the model is found in Rowthorn's (1977) inaugural contribution. The author assumes that firms fully index prices when inflation exceeds a threshold. We introduce this assumption by taking $\psi_2 = 1$ in equation 1.12, when the inflation rate is above the threshold. In this case, it follows that the equilibrium wage-share exactly corresponds to the wage-share targeted by firms. Thus, the equilibrium wage share is not affected by the workers' target, and an increase in ω_w only affects inflation and money wage growth. Hence, workers' aspiration gap is not partially closed by real wage increases. Rowthorn (1977) further assumes that above the same threshold, workers include expected inflation in their wage claims. Consequently, even though workers cannot affect real wages through money wage increases (because firms can immediately raise prices), a persistent aspiration gap and the impact of expectations lead to increasingly higher wage demands. In these conditions, small cost shocks may drive the economy towards an accelerationist process (Rowthorn, 1977, p.227-229).[14] However, since workers are no longer able to affect income distribution, it is hard to justify the rationality behind higher wage demands (in case its *real* outcome is supposed to be null).

In spite of its contribution, Kaleckian conflicting claim models contain unsolved theoretical shortcomings. Next section discusses critiques on the Kaleckian explanation of distribution embodied in these inflation models. As an alternative, we explore a Classical-Keynesian contribution to inflation theory.

[14] The same outcome of the assumption of complete price indexation emerges if firms have a complete bargaining power, *i.e.* if the parameter ψ_1 tends to infinity. In this case, "[f]irms do not let the margin of profit fall below its target level and they can respond immediately to any increase in their wage costs" (Lavoie, 2014, p. 552). Hence, workers are not able to affect the real wages by means of wage bargaining.

1.5 The Classical-Keynesian approach to inflation

1.5.1 Critique on the Kaleckian distributive closure

In the Kaleckian view, firms set prices following a mark-up on average unit costs rule. The magnitude of this mark-up depends on the average of the market prices for the same commodity, weighted by the quantity produced by each firm (Kalecki, 1954, p.12-18). However, Pivetti (1991, p.105-119) argues that basing the determination of mark-up on the degree of monopoly does not provide a proper explanation of income distribution. Pivetti (1991) argues that as the competition among firms can change market-shares, the weights would oscillate, leaving the mark-up unstable or indeterminate. Moreover, this measure does not consider the role of potential entrants. A high mark-up (associated with a high profit rate) can attract new entrants to the market. Naturally, we expect that incumbent firms anticipate this possibility and set prices within certain limits to avoid losing market-share[15]. More importantly, this explanation of the mark-up does not set a lower limit for the profit rate. This framework seems to allow for the possibility of a profit rate equal to zero in a fully competitive industry. It does not explicitly consider the requirement of a minimum positive profit rate for capitalists to carry on production (Pivetti, 1991). Finally, as shown before, the process of wage bargaining and price inflation sets an equilibrium mark-up different from the one consistent with the degree of monopoly. In this case, the distributive conflict changes the mark-up, even when the market structure across industries remains the same. Hence, the link between the degree of monopoly and income distribution is loosened, weakening the explanatory power of the former.[16]

Furthermore, Steedman (1992) argues that Kaleckian mark-up pricing overlooks implications of input-output relations. In other words, it does not explicitly consider that firm's costs depend on other firm's prices — and, hence, on the mark-ups found in

[15] See, for instance, Sylos Labini (1957).

[16] In his earlier writings Kalecki had shown skepticism regarding the ability of workers to affect functional income distribution through wage bargaining (see, for instance, Kalecki, 1943). In 1954, in *Theory of Economics Dynamics*, Kalecki broadened the notion of degree of monopoly to include the effect of workers' bargaining power. Kalecki (1954) expressed the wage share as an inverse function of (an aggregated measure of) mark-up, determined by the degree of monopoly across different industries. However, he also pondered that strong trade unions may reduce the degree of monopoly (Kalecki, 1954, p. 17-18). According to Kalecki (1954, p. 18), a "high ratio of profits to wages strengthens the bargaining position of trade unions in their demands for wage increases since higher wages are then compatible with 'reasonable profits' at existing price levels". This process pressures profits, encouraging firms to adopt a "policy of lower profit margins". The argument was further explored in Kalecki (1971). See also López (2010, p. 67-90), Rugitsky (2013) and Pivetti (1991, p. 108-113).

other industries. Steedman (1992) adds that the average mark-up of the economy cannot be properly defined as an 'average'. The problem is that the weights of this average (the output value of different industries) depend on relative prices and, thus, on the mark-ups. Finally, competition implies that mark-up in one industry cannot remain persistently independent of the mark-up in other industries. However, if this is the case, the concentration within each industry might no longer be the main determinant of the respective mark-up.

1.5.2 Inflation in the Classical-Keynesian approach

The Classical surplus approach, recovered by Sraffa (1960), relies on political and institutional factors to explain income distribution. Relative prices and distribution are determined together in the same step of the analysis (within the same system of equations). Therefore, the interaction between inflation and distributive conflict emerges straightforwardly.

The Classical approach distinguishes normal and market values for prices and distributive variables in order to introduce a systematic analysis of the long-term regularities observed in capitalist economies (Eatwell, 1982). In this view, competition within markets establishes a normal price for commodities around which market prices tend to gravitate. Normal prices (or production prices) are set according to persistent long-term forces affecting prices and distribution. Temporary changes in effectual demand, for instance, are assumed to affect market prices without affecting normal prices. Competition among capitals also generates a tendency of convergence towards a normal profit rate. Thus, production price is defined as the price required for production to be regularly brought to market, standing for a necessary condition for supply. Hence, production prices must be enough to repay inputs costs, as well as wages, profits, and rents in its normal rates, which hold under competition (Salvadori and Signorino, 2013; Vianello, 1989).

Nevertheless, the system of price equations proposed by Sraffa (1960) analyzes real variables: relative prices, real wages, and (real) profit rate. This system allows for different distributive closures. Classical economists analyzed distribution taking the real wage as determined according to the socially established level of subsistence (Stirati, 1994). In this case, the profit rate is determined as a residual in the system of price equations, together with relative prices. History has shown, however, that workers may be able to decouple real wages from the subsistence level, obtaining also a share of the surplus (Pivetti, 1999; Sraffa, 1960). For this reason, Sraffa (1960) takes the profit rate as exogenous with respect to the system of price equations, thereby determining real wages endogenously and together with relative prices. The author also suggested that the profit rate is determined according to the level of the money interest rate.[17] As we see below, Pivetti (1991) builds on this suggestion, which also allowed for an analysis of inflation.[18]

Studying inflation requires taking an additional step. We must define not only the set of relative prices but also the price level. Addressing this issue, Pivetti (1991, 2007) introduces money wages, and the interest rate (as a monetary determinant of the profit rate) into the price equations system, obtaining the price level and commodity prices expressed in money proper.[19]

Stirati (2001) follows the same procedure, setting a framework to discuss inflation along the lines of the Classical surplus approach. Starting with *nominal* production prices, equation 1.14 presents the price equations in matrix form.

$$\boldsymbol{P} = \boldsymbol{PA}(1+i) + \boldsymbol{PA\rho} + \boldsymbol{l}w \qquad [1.14]$$

In this equation, $\boldsymbol{P}$ represents a row vector of prices. The technical coefficients are given by $\boldsymbol{A}$, a squared matrix of input coefficients per unit of output, and $\boldsymbol{l}$, the row vector of labor inputs per unit of output. We will assume these technical coefficients remain unchanged. In turn, w stands for the money wage (uniform across industries, by assumption), and i stands for the nominal interest rate. Finally, $\boldsymbol{\rho}$ represents a diagonal matrix of industry-specific premiums compensating risk and market-power.[20] Since $\boldsymbol{\rho}$

[17] As stated by Sraffa (1960, p.33): "The rate of profits, as a ratio, has a significance which is independent of any prices, and can well be 'given' before the prices are fixed. It is accordingly susceptible of being determined from outside the system of production, in particular by the level of the money rates of interest".

[18] In the last decades, advanced economies presented low interest rates along with fall in the wage share. This event may have raised interpretations that real wage rate decrease independently from movements in the interest rate (Stirati, 2013). If this is the case, the real wage rate would regain its analytical position as the external variable to the production system. In contrast, the profit rate would be determined as a residual. Stirati (2013) also explores alternative interpretations to this phenomenon in the light of the Classical surplus approach to distribution.

[19] In the author's words: "Given the rate of interest to be earned on long-term riskless financial assets, and given the money wage, which is the direct outcome of wage bargaining, the price level can be determined in a system of price equations *à la* Sraffa (in which, however, both the wage rate and commodity prices are expressed in money proper), together with the distribution of income between profits and wages" (Pivetti, 2007, p. 243).

[20] The compensation of market-power depends on the existence of persistent barriers to entry restraining the equalization of profit rates by competition. This component is associated with features of the industry, as minimum operational scale and initially required investment. In the Classical surplus approach, competition

tends to be stable, we assume that it is equal to zero to focus on the impact of changes on wage rate and interest rate.

Furthermore, equation 1.14 shows that the interest rate is assumed to determine the normal profit rate, following the monetary theory of distribution (Pivetti, 1991). In other words, the money spent in the purchase of inputs in the previous period yields an earning equivalent to the interest rate on the anticipated investment. According to Pivetti (1991), if competition equalizes earnings of different applications of capital, then the normal profit rate cannot persistently differ from the interest rate. Since the nominal interest rate is considered a monetary phenomenon, autonomously set by the monetary authority — accounting for political and economic constraints —, it must determine the normal profit rate rather than the opposite.[21] A nominal determination of the (thus, nominal) normal profit rate implies that the real outcome for the profit rate is affected by inflation, as we discuss later.

In equilibrium, the price level and relative prices are stable and are determined as in the equation 1.15 — where $\boldsymbol{I}$ represents the identity matrix.

$$\boldsymbol{P} = \boldsymbol{l}[\boldsymbol{I} - (1+i)\boldsymbol{A}]^{-1}w \tag{1.15}$$

By post-multiplying the row vector of prices by a column vector representing quantities (which can be, for instance, proportional to the output or the consumer's bundle), we obtain a measure of the price level. Let us consider the column vector $\boldsymbol{Q}$, as the vector of output. Then, a measure for inflation (π) can be obtained as in equation 1.16. Note that this measure corresponds to the output deflator.

$$1 + \pi_t = \frac{\boldsymbol{P}_t \boldsymbol{Q}}{\boldsymbol{P}_{t-1} \boldsymbol{Q}} \tag{1.16}$$

In this framework, inflation arises during the transition between two long-period positions of relative prices and income distribution. From the previous expressions, it is

is related to free mobility of capital across industries, while market-power arises when capital movements face some restraint (Eatwell, 1982; Salvadori and Signorino, 2013).

21 More precisely, the author argues that the normal profit rate of each productive sector is determined by two components (Pivetti, 1991). The first is the interest rate of long-term fixed and risk-free security, best represented by public securities. The second component corresponds to the remuneration of 'risk and trouble' of productive investment, changing according to the economic sector. This second component is captured in the price equations (1.14) by the matrix $\boldsymbol{\rho}$.

evident that, in the absence of changes in the technical coefficients, changes in w and i (which correspond to the basic distributive variables) regulate the changes in the price level.

Competition constraints firms to set prices following the price of capital goods at the beginning of the production process: the historical cost of capital. This comes from the following reasoning. The interest rate on the free-risk asset sets the minimum return on advanced capital to allow production to happen. Hence, competition among capitalists will bring the return on advanced capital in production into equality with the risk-free interest rate (abstracting from the industry-specific premium compensating illiquidity). Different investment opportunities must yield the same return in proportion to the amount of capital advanced in the presence of competition. Hence, capital advanced in production taking place from period t to $t+1$ must provide the same return as the interest rate of the risk-free asset. This return must be proportional to the monetary value of the capital advanced in period t, either in the form of capital goods or bonds. In the case of productive investment, this value corresponds to the historical costs of capital (Pivetti, 1991).

As prices may change in time, the cost of inputs required for production can rise. In this case, a discrepancy between the historical cost of capital and reproduction costs of capital arises, *i.e.*, the value of capital at the end of the production period. Reproduction cost of capital "is actually the relevant magnitude as far as the rate of profit is concerned, since profits are what remains of the value of the product after deducting wages and the reproduction cost of capital" (Pivetti, 1991, p. 53). Under these conditions, changes in the production costs (as wage increases) can change the profit rate as measured in terms of the reproduction cost of capital.

As Stirati (2001) shows, assuming the interest rate remains stable at its initial level (i_0), the profit rate will be given by equation 1.17. Using the result in equation 1.16, we can obtain equation 1.18, which expresses the profit rate as the ratio between the nominal interest rate and the rate of change in the price level.

$$(1+r_t) = (1+i_0)\frac{\boldsymbol{P}_{t-1}\boldsymbol{Q}}{\boldsymbol{P}_t\boldsymbol{Q}} \qquad [1.17]$$

$$(1+r_t) = \frac{(1+i_0)}{(1+\pi_t)} \qquad [1.18]$$

This result sets a relation between inflation and distributive conflict because wage increases affect distribution at least temporarily. After a while, real wages return to their previous value as higher costs are passed through into prices if there are no further wage increases. Nevertheless, a persistent change in distribution can occur if money wages keep increasing at a stable rate (Pivetti, 1991; Stirati, 2001). Suppose the rate of interest determines the normal profit rate. In that case, the *real* rate of interest is the one consistent with the distributive result after changes in money wages and prices (Pivetti, 1991). Then, the profit rate would not only depend on the nominal interest rate but also on the growth rate of money wages (Pivetti, 2007; Serrano, 1993). Therefore, together with monetary policy, the bargaining power of workers can determine income distribution.

This approach provides a useful framework for discussing the sources of inflation, its impact on distribution, and its relationship with unemployment,[22] consistently with both the conflicting claims view and classical theory of distribution (Stirati, 2001). One of its distinctive features corresponds to taking the profit rate as determined according to the monetary theory of distribution. Distribution is also affected by the monopoly power generated by restrictions to competition (which appear in the variable ρ in equation 1.14). Nevertheless, according to the monetary theory of distribution, monopoly power may affect distribution, but it cannot be considered the ultimate cause of profits (Pivetti, 1991, p. 108-113). This view contrasts with Kaleckian models of inflation in which distribution depends on the degree of monopoly and the relative bargaining power of workers in wage negotiations *and* on bargaining power of firms in price setting.

[22] As in the Phillips curve. See Stirati (2001) and Serrano (2019).

1.6 Final Remarks

Inflation emerges from the dispute among social groups over the distribution of the surplus. As incomes are defined in nominal terms, price changes affect their purchasing power. Prices rise when the claims of social groups are incompatible with the total income generated in production.

The consistency of the view that conflict is the main cause of inflation depends on two important premises. First, earnings are set in nominal terms. That is the case for wage agreements (Keynes, 1937, p. 8-9), but also for profits (Pivetti, 1991). When workers resist the fall in nominal wages, they prevent real losses. Therefore, nominal changes affect income distribution. Nevertheless, models assuming full indexation of prices to money wages do not allow for changes in distribution (as in Rowthorn, 1977). These models have thus been considered incompatible with the conflict inflation view (Serrano, 2010).

Second, income distribution does not converge towards a predetermined real equilibrium. This premise implies that the conflict over wage agreements and other nominal distributive variables has a persistent effect on distribution. If otherwise, conflict had a merely temporary effect on distribution, it could only be a transient and eventual cause of inflation (as in Carlin and Soskice, 2014). In that case, the main causes of inflation must be elsewhere (as excess demand and expectations in the New Keynesian Phillips curve). In the Kaleckian perspective, accepting the persistent effect of conflict over income distribution violates the determination of distribution according to the forces of competition. That perspective can be consistent only if one is willing to concede that the wage bargaining process is inside the Kaleckian definition of the degree of monopoly of firms (as done in Reynolds, 1983). Recent contributions rely on firms' bargaining power to explain the mark-up, combining the role of the forces of competition and firms' relative power with respect to workers (Lavoie, 2014).

Under these two premises — namely, if income distribution is affected by nominal variables, and is not tied to a predetermined real equilibrium — conflict can be a persistent cause of inflation.

These conditions are unambiguously attended in the Classical-Keynesian approach. This approach analytically separates the theory of value and distribution from the theory of output and accumulation (Garegnani, 1983). Differently from the marginalist approach, income distribution is not determined by factors' productivity. Rather, income distribution does not maintain a necessary functional relation with output or other production variables in the Classical-Keynesian approach (Garegnani, 1983).

Distribution is affected by political and institutional factors, which express the dispute of social classes over the surplus. That reveals the contingent and historical nature of income distribution in economic systems, particularly capitalism. Inflation, wage bargaining, and changes in nominal variables are one sphere of the distributive conflict (Pivetti, 1991; Serrano, 1993; Stirati, 2001). Expressing the price equations system in money proper connects the Classical approach to distribution with conflict inflation, thereby setting a monetary theory of distribution (Pivetti, 1991). Therefore, nominal variables can permanently affect distribution.

Inflation is dominantly a cost-push phenomenon in conflict inflation (Morlin, 2021). Theories of inflation relying mainly on excess demand are not compatible with this view. We discussed the New Keynesian Phillips curve, exposing its main weaknesses as the notion of a natural interest rate (Petri, 2019), the assumption of a stable NAIRU (Storm and Naastepad, 2009), and the incompatibility with recent economic events (Stirati and Paternesi Meloni, 2018; Summa and Braga, 2020). Conversely, the empirical regularity captured in the Phillips curve can be understood as an outcome of wage bargaining and cost-push inflation. The lower the unemployment rate, the greater workers' bargaining power is, which speeds up wage growth and thus inflation (Rowthorn, 1977; Serrano, 2019; Stirati, 2001). In contrast with the New-Keynesian view, the interaction between inflation and income distribution in this conflict-augmented Phillips curve is a source of non-neutrality of money both in short and in the long run (Pivetti, 2007; Serrano, 2019).

This chapter reviewed competing explanations for inflation. We focused on conflict inflation theories, comparing the underlying distributive closures. We argued that the Classical-Keynesian approach provides a straightforward foundation to conflict inflation theory, thereby being advantageous with respect to the Kaleckian foundations of conflicting claims models.

After this review on conflict inflation theory, we can move forward to the next chapter. We will discuss open economy models of inflation. New sources of distributive conflict emerge, and additional variables must be considered as the exchange rate and international prices. Finally, we develop a conflicting claims model for a price-taker open economy, building on the conclusions of the present chapter.

Chapter 2

Inflation and conflicting claims in the open economy

2.1 Introduction

International causes are found in the explanation of inflation since the creation of the word "inflation" during the European price revolution in the sixteenth century.[1] As described later in Hume's specie flow mechanism, price increases were believed to arise because of the vast gold inflow from colonies (Green, 1982). In contrast to these early formulations of the Quantitative Theory of Money, alternative explanations back then linked rises in the price level with rising costs, exchange rate devaluations and income claims of landowners (Arestis and Howells, 2001, p. 188). Later on, during the Napoleon wars, external cost shocks following the English trade blockage appeared among explanations of inflation (Smith, 2011, p. 88-94). The interaction between inflation and the exchange rate was also explicit in the German hyperinflation debate. In contrast with the dominant monetarist explanation, an alternative interpretation claimed that the external debt owing to war reparations caused exchange rate devaluations, leading to hyperinflation (Câmara and Vernengo, 2001; Robinson, 1938). In the post-war period, Latin American structuralist economists emphasized the role of the balance of payments and exchange rate devaluations in inflation (Furtado, 1954, 1963; Noyola Vázquez, 1956; Sunkel, 1958). The focus on international causes was not exclusive of peripheral

[1] During the sixteenth and the first half of the seventeenth century, Western European economies faced a period of slow and continuous rise in price levels. This process stimulated a seminal debate on inflation and money, with some of the first formulations of the quantitative theory of money.

economies, though, as they were also present in European debates in the context of small-open economies (Aukrust, 1977; Edgren et al., 1969; Frisch, 1977). Afterward, the overall importance of international prices was unavoidable during the oil-shocks in the 1970s (Gordon, 1984). Arising challenges due to external shocks turned the attention of some economists to money wages-exchange rate inflationary spiral.[2] In Latin American countries, chronic Balance of Payments deficit and repeated exchange rate devaluations sustained high inflation, provoking episodes of hyperinflation. Once more, international prices and exchange rate devaluations gained centrality among explanations of high inflation. The stability of the exchange rate was among the main policy instruments employed to correct it (Bastos, 2002).

Growing international integration in recent times inspired criticism against the dominance of country-centric approaches to inflation for focusing mainly on domestic variables (Borio and Filardo, 2007). On the contrary, international factors are shown to account for much of national inflation dynamics across countries (Bobeica and Jarocinski, 2019). Furthermore, global inflation rates act as an attractor for national inflation rates (Ciccarelli and Mojon, 2010). Therefore, analysis of inflation should account for the high substitutability of tradable goods, pressures of international competition, mobility of labor, and the great importance of cross-border input-output linkages. Acknowledging these effects implies focusing on international prices of goods and inputs, foreign wage rates, and exchange rates (Bugamelli et al., 2015). In this regard, Auer et al. (2017) found that trade in intermediate goods and services is the main transmission mechanism of global slack to domestic prices. Moreover, Auer et al. (2019) show the relevance of international input-output linkages in explaining the high synchronization of inflation among different countries. These results stand out for reclaiming the role of the cost channel as an important transmission mechanism of international shocks to domestic inflation.

Inflation models have typically dealt with open economy concerns by including non-competing imported inputs among production costs — as in Rowthorn (1977), Stirati (2001), Lavoie (2014). Features of contemporary open economies, however, suggest further properties must be introduced in inflation models. *Inter alia*, inflation models should consider that many domestic prices follow prices of the international market. More generally, domestically produced tradable goods are exposed to foreign

[2] This was the case of Ezio Tarantelli, who proposed different stabilization policies in Italy (Michelagnoli, 2011). In the United Kingdom, search for Balance of Payments equilibrium justified the adoption of incomes policy and wage controls (Tarling and Wilkinson, 1977).

competition so that their prices cannot be taken as independent from foreign prices. If so, foreign prices must also affect domestic income distribution. Hence, inflation in open economies interacts with income distribution, which is the domain of conflict between social classes.

2.2 Inflation in the open economy

The introduction of (non-competing) imported inputs in production permitted the extension of closed economy models to open economy (Rowthorn 1977, Stirati 2001, p. 436-9; Hein and Vogel 2008). Alternatively, conflict may also emerge from the presence of imported consumption goods as part of workers' bundle, as shown by Cassetti (2002). However, we discuss the case more frequent in the literature in which imported inputs are required for domestic production. Following Hein and Vogel (2008), equation 2.1 introduces imported inputs by means of a small change in equation 1.6. In this case, a unit of output is produced with a combination of labor and an imported input. The input's price corresponds to a given international price (p^*_μ) times the nominal exchange rate (e). The input is employed in the quantity a_m.

$$P_t = (1 + \mu_t)(w_t l_t + a_m e_t p^*_{m,t}) \quad [2.1]$$

The profit share is described in equation 2.2. For a given wage rate, the profit share increases with the mark-up, the international price, the exchange rate, and the coefficient a_m.

$$\Pi_t = \frac{1}{1 + \frac{1}{\mu_t(1+z_t)}} \quad [2.2]$$

where

$$z_t = \frac{a_m e_t p^*_{m,t}}{l_t w_t}$$

Additional sources of inflation and distributive conflict emerge here. Concerning the impact on prices and distribution, both a uniform rise in international prices and an exchange rate devaluation present the same effect in these models. Either of these shocks proportionally increases the value of imported inputs as measured in domestic currency, thus raising production costs.

For the sake of exposition, let us assume, at this moment, that prices do not adjust instantaneously after an external shock. The immediate consequence is a fall in the profit share due to the higher replacement costs of capital. As higher costs are passed through into prices, the ratio of prices to current reproduction costs is restored to its initial value, while the external shock burden is transferred to real wages.

In the equations above, however, the adjustment of prices to costs is assumed to happen instantaneously. Because of this assumption, the real value of the mark-up – *i.e.*, the ratio between prices and current reproduction costs — is constant. In either case, as final prices adjust to larger input costs, profit share becomes larger than before. This effect can be seen in equation 2.2, in which a larger cost of imported inputs (larger value of p^*) implies larger z_t and, thus, a larger profit share (Π_t). As a counterpart, both the wage share and real wages fall. Then, the burden is increasingly transferred to workers as real wages fall due to the increase in the price level. Putting it differently, the increase in the price of imported inputs (as measured in the domestic currency), *ceteris paribus* reduces the National Income available to be distributed among workers and capitalists. If the mark-up is assumed constant, the higher costs are completely pass through into prices leaving all the burden to workers in the form of a lower real wage and a lower wage share. Nevertheless, a lower real wage may trigger reactions in the form of wage claims, leading to an inflationary process.

In sum, higher costs of imported inputs imply either lower mark-up or lower real wages – or an intermediary situation in which losses are shared between capitalists and workers. In Rowthorn (1977), complete and instantaneous pass-through ensures that the burden falls on workers – whose reaction only leads to the acceleration of inflation. However, the intermediary situation tends to prevail in other models (Bastian and Setterfield, 2020; Blecker, 2011; Lavoie, 2014).

The discussion on inflation in the open economy also considers the role of the exchange rate. In some models (as Vera, 2010; Blecker, 2011; Vernengo and Perry, 2018), a target for the real exchange rate is associated with a policy orientation to avoid — or reduce — deficit in the trade account of the Balance of Payments. However, this policy choice depends on the Marshall-Lerner condition, which establishes the requirement for an exchange rate devaluation to improve the balance of trade account. A nominal devaluation increases the trade surplus whenever the response of quantities of exports and imports more than compensate for the change in prices associated with the devaluation. Thus, starting from equilibrium in the trade account, an exchange rate devaluation rises the trade surplus if the sum of the absolute value of the demand elasticities of export and imports is larger than one. Let us assume an external shock in the form of a nominal exchange rate devaluation, pursued by a monetary authority targeting a certain value for the real exchange rate. Even if the targeted real exchange rate is achieved at the moment of the devaluation, the propagation of inflation through wage and price increases partially offsets the previous real devaluation. This propagation, in turn, can lead to additional nominal devaluations, imposing a pattern of chronic devaluations and a race between exchange rate and money wages (Bastian and Setterfield, 2020; Blecker, 2011).

Departing from Dornbusch (1980), Vera (2010) explicitly introduces the Balance of Payments. In a first analytical exercise, the author assumes imported goods are part of the workers' bundle. In a second step, he also includes imported inputs to domestic production. Finally, Vera considers mark-ups to be flexible and positively affected by the real exchange rate. This framework is set up to approach a small economy running Balance of Payments deficits and subsequent exchange rate devaluations, causing persistent inflation.

The argument builds on the interpretation developed (though not explicitly formalized) by the Latin American Structuralist School since the 1950s (Pérez Caldentey, 2019). In this view, underdeveloped economies faced structural deficits in Balance of Payments due to the need for industrial imported goods and the secular decline of terms of trade.[3] In turn, this leads to repeated devaluation, which explained the chronic inflation of Latin American economies. Propagation mechanisms would explain the persistence of inflationary pressures after an external shock. Notably, some structuralists as Furtado (1954, 1963) and Noyola Vázquez (1956) placed conflicting claims among the propagation mechanisms (Pérez Caldentey, 2019). Thus, "[i]f after an inflationary shock a group is dissatisfied with its income share it will try to pass its losses to another group" (Vernengo and Perry, 2018, p. 127).

Along these lines, Vernengo and Perry (2018) discuss the impact of a deterioration in Balance of Payments on inflation in a simple model. The analysis assumes that monetary authorities target a value for the real exchange rate, pursued by adopting a nominal depreciation rule – namely, crawling pegs. By adopting this policy, authorities aim to stimulate exports, seeking for trade account surplus to pay for external debt service. Hence, an increase in the international interest rate (as the Volcker shock in the 1970s) rises the targeted real exchange rate, leading to exchange rate devaluation. After that, the exchange rate shock is propagated through wage indexation. Nevertheless, the model assumes a given rule of indexation, not addressing the distributive conflict explicitly.

[3] Following the Prebisch-Singer hypothesis.

Charles and Marie (2016) propose a similar effect with a different argument. In this model, firms are indebted to the international capital market and must pay debt service in international currency. Firms' pricing decision includes the cost of debt service in final prices. Therefore, if debt-service cost increases either because of exchange rate devaluation or raises in international interest rate, then firms raise prices. Monitoring trade account balance allows firms to form expectations about the future exchange rate. In this way, firms anticipate the impact of devaluation on costs of debt service and imported inputs, raising final prices. An external shock can therefore provoke an inflationary spiral. Under extreme conditions, it can lead to hyperinflation (Charles and Marie, 2016). As Vernengo and Perry (2018), Charles and Marie do not explicitly deal with distributive conflict but assume a given indexation of wages to inflation. However, indexation is assumed incomplete in the former and complete in the latter.

In different ways, the models discussed advance in the treatment of inflation in the open economy, dealing with Balance of Payments, and interacting with distribution. These models try to formally introduce Balance of Payments disequilibria as a source of chronic inflation (as well as high inflation and hyperinflation), which is compatible with the typical situation observed in peripheral economies. Notably, these studies assume the Marshall-Lerner condition to hold, establishing a positive relationship between real exchange rate and trade account balance.

Introducing Balance of Payments concerns in the analysis of inflation reveals the distributive role of the exchange rate and international prices. However, a domestic mechanism of propagation of the external shocks must be present to generate persistent inflation.

When reviewing the work of Bresciani-Turroni on the German hyperinflation in the inter-war period, Joan Robinson (1938) explicitly assigns a central role to money wage increases in the explanation of hyperinflation. Wage increases were a response to the rise in the cost of living due to sharp exchange rate devaluations. Money wages increase further rose production costs, worsening the trade account balance and leading to additional devaluations. This process generated an inflationary spiral of money wages and nominal exchange rate.[4] The trigger of the crisis was the external debt created by

[4] "With the collapse of the mark in 1921, import prices rose abruptly, dragging home prices after them. The sudden rise in the cost of living led to urgent demands for higher wages. [...] Wage rises had to be granted. Rising wages, increasing both home costs and home money incomes, counteracted the effect of exchange depreciation in stimulating exports and restricting imports. Each rise in wages, therefore, precipitated a further fall in the exchange rate, and each fall in the exchange rate called forth a further rise in wages". (Robinson, 1938, p. 510)

the reparation payments imposed in the Treaty of Versailles (Câmara and Vernengo, 2001).

Later on, Latin American structuralist scholars argued that distributive conflict is a mechanism of propagation of inflation. In this view, conflict contributes to the propagation of inflationary shocks coming from structural conditions — as a tendency towards deficit positions in Balance of Payments, productivity bottlenecks, and the inelasticity of supply (especially of food-related products, because of the land concentration and low productivity of agriculture for the domestic market) (Furtado, 1954; Noyola Vázquez, 1956; Sunkel, 1958). International prices obtain relevance in this analysis since they influence the trade account balance. Therefore, a declining trend of terms of trade is placed among the structural conditions that worsened the trade deficit, causing further nominal devaluations and, thus, inflation.

Nevertheless, an improvement of terms of trade can also be inflationary. Celso Furtado (1963) explains this effect in his analysis of the impact of coffee prices on Brazilian inflation.[5] Furtado (1963, 246-258) describes two different transmission mechanisms through which the increase in the international price of an exported commodity (with a relevant share in the output) causes inflation. First, a direct immediate mechanism in the form of an increase of the domestic price of the same commodity. The second effect concerns a distributive channel. A higher price of the exported commodity increases the compensation of productive resources allocated in the exporting sector — as land rent. As a consequence, a larger portion of land would be dedicated to the exported commodity, reducing the domestic supply of foodstuff. Given the effective demand for food, a smaller supply tends to raise prices. Competition across different productive uses of land leads the economy towards a position in which these prices are enough to cover the higher land rent observed in the exporting sector. In sum, a persistent increase in the coffee price would raise the land rent, increasing prices of other agricultural commodities sold in the domestic market. As Furtado (1963, p. 257) states: "If the exporting sector, as in Brazil, comprises an extremely important sector of agriculture, it is perfectly natural that the factors connected with the domestic market will try to bring their rewards into line with the level established in the exporting sector, at least in a regional basis". Hence, this direct interaction between international prices and income distribution introduces an additional element to the analysis of inflation in open economies.

[5] In the period, coffee was the main commodity exported by Brazil.

The effect of international prices on inflation in small open economies was also discussed in the Scandinavian model of inflation[6] (Aukrust, 1977; Edgren et al., 1973).[7] This model departs from a distinction between two economic sectors: one tradable and the other non-tradable. The tradable sector has its prices determined in the international market, thereby causing its prices to be insensitive to changes in domestic costs. In contrast, non-tradable sector prices depend directly on their costs once they are not constraint by foreign competition. The two sectors also differ with respect to productivity growth since the tradable sector contains industries leading productivity growth (as manufacturing) in contrast with the non-tradable sector (composed of services, among other activities). The nominal exchange rate is assumed to remain constant in the model, according to the rules of the Bretton Woods agreement, then in force. Moreover, price increases and productivity growth in the tradable commodity are completely absorbed by money wage increases in the same sector. Authors assume that wage growth spreads to the other sector, either because of competition in the labor market or unions activity. This assumption leads to a higher price increase in the non-tradable industry with respect to tradable prices. Thas occurs because of the slower productivity growth in the non-tradable industry. Thus, as international inflation directly determines the rate of increase in prices in the tradable sector, it also affects the money wage increase which — discounted of the productivity growth of the non-tradable sector — determines the price increase in the non-tradable sector. Altogether, this defines the inflation rate of the economy as completely determined by international inflation and domestic differential of productivity (Aukrust, 1977; Edgren et al., 1973). If wages diverge from the rule imposed by the model, then income distribution changes. However, Edgren et al. (1969, 1973) aimed to prevent changes in distribution (avoiding "excessive" wage claims), claiming this condition would preserve investment, growth, and Balance of Payments equilibrium (refer to Morlin and Bastos (2019b))[8].

As emphasized in the Scandinavian model, in the context of price-taker open economies, firms cannot pass through increases in domestic costs into prices of tradable

[6] See Canavese (1982) for comparison between European and Latin American structuralist explanations of inflation. See also Frisch (1977) and Morlin and Bastos (2019b).

[7] As pointed by its original proponent, the Scandinavian model builds on the "recognition that the developments of prices and incomes in small and medium-sized economies are strongly affected by events in the outside world and that, for this reason, price theory, more than hitherto, should address itself explicitly to the problems of open economies." (Aukrust, 1977, p. 109)

[8] Morlin and Bastos (2019a) discuss the historical context in which this model was developed.

commodities. Therefore, when wages grow faster than the rise in international prices, profits are compressed in these industries. In a similar reasoning, Blecker (1989a, 2011) introduces flexible mark-ups in price equations for open economies, in contrast with the usual fix mark-ups of other Kaleckian models of inflation.

Introducing flexible mark-ups " creates the possibility that profit margins may be 'squeezed' between high domestic costs and low foreign prices" (Blecker, 1989a, p.396). Hence, mark-ups are assumed to be a positive function of the real exchange rate. A real depreciation makes foreign competing commodities relatively more expensive, allowing domestic firms to raise mark-ups (Blecker, 2011). Nevertheless, if mark-up pricing presents weaknesses, as discussed in the previous section, the notion of flexible mark-up brings an additional problem. Under flexible mark-ups, it is not clear to which extent the degree of monopoly still determines the mark-up while, at the same time, it is supposed to change with the real exchange rate. An additional problem could arise when considering sectorial mark-ups. A sector with a high degree of monopoly could have a lower mark-up than another sector in which domestic competition is more intense, although being more protected from international competition (by its nature, as non-tradable goods, or institutional features, as trade barriers). In any case, the flexible mark-up brings within an inflationary pressure, generated by a profit-claim of capitalists associated with a real depreciation. In this regard, Blecker (1989a, p. 406) stresses the distributive effect of a real depreciation: "a depreciation is equivalent to a money wage cut, since it redistributes income to profits." Finally, flexible mark-ups allow for modeling the interaction between international prices and distribution without setting tradable prices as directly determined by international prices — in other words, withdrawing the price-taker hypothesis and disregarding the law of one price.

From an empirical viewpoint, evidence shows that international variables as foreign prices, cross-border input-output linkages, and measures of trade integration play a relevant role in explaining inflation in advanced and developing economies. These results are discussed in the Chapter 3 of this thesis.

2.3 A formal model of inflation in an open economy

2.3.1 Distributive closure in the open economy

Developments in trade theory within Classical-Keynesian approaches build on the extension of production prices to the open economy case, focusing on the determination of trade and specialization as a problem of choice of technique (Steedman, 1999). Although an ultimate closure for the determination of distribution within open economies remains unresolved, this approach can bring useful insights into a conflicting claims modeling. Notably, open economies require accounting for the exchange rate and international prices as relevant determinants of domestic prices and income distribution (Metcalfe and Steedman, 1981). For the purposes of this paper, we depart from a simple setup, which allows us to focus on inflation and its interaction with distributive variables.

Let us consider the case of a price-taker open economy producing two commodities: one tradable machine (commodity 1) and one non-tradable consumption good (commodity 2) — as in Steedman (1999). Production in both industries requires non-competing imports as inputs (denoted by the subscripts m and μ), and an amount of the tradable machine and labor. Labor is assumed homogeneous, thereby equalizing the wage rate in the two sectors. Moreover, capitalist competition implies that the profit rate is uniform across sectors in the long period position. We assume production takes one period of time. Wages are set at the beginning of this period and paid at the end (*post-factum*).

$$p_1 = (a_1 p_1 + a_m p_m)(1+r) + wl_1 \quad [2.3]$$

$$p_2 = (a_2 p_1 + a_\mu p_\mu)(1+r) + wl_2 \quad [2.4]$$

$$p_1 = ep_1^* \quad [2.5]$$

The price of commodity 2 follows a customary production price equation as in 2.4, summing unit labor costs and unit costs of circulating capital added of a profit rate. In contrast, the price of the tradable machine is constraint by international competition. An economy is a price-taker in a particular commodity in the international market when it is not able to satisfy the world demand for this commodity with lower costs than the other countries.[9] Thus, the domestic price for 1 follows that the international price (p_1^*) as measured in domestic currency (given the nominal exchange rate e) – as in equation 2.5.

In addition, we define the real wage rate as the ratio of money wages to the price of the consumption good.

$$w_R = \frac{w}{p_2} \qquad [2.6]$$

The distributive closure for this price-taker open economy consists of an endogenous determination of the profit rate in the production of the tradable good.[10] This is equivalent to taking the real wage as an exogenous variable in the price equations for the long period position (Metcalfe and Steedman, 1981).

Real wage (and not the profit rate) defines the distributive closure because it is completely determinate once we know money wages and the nominal exchange rate. We build on two realistic assumptions. First, money wages are determined in the wage bargaining process. Second, the nominal exchange rate is a monetary variable.[11] In this regard, Lavoie (2000a, 2002), Smithin (2002) and Vernengo (1999), argue that open economies with a sovereign currency can carry on monetary policy with substantial degrees of freedom. These authors extend the Post-Keynesian view on the autonomy of monetary authority in pegging interest rates to the open economy case. In this case, Central Banks set domestic interest rates, taking into account the international interest rate, the Balance of Payments, the stock of foreign currency reserves, and domestic variables as inflation and employment. As in uncovered interest parity, movements in the nominal exchange rate depend on the monetary policy, which regulates the difference between domestic and foreign interest rates[12]. For this reason, Smithin (2002)

[9] When talking about small economies, we are referring to price-taker open economies. This implicit linkage between these two different ideas derives from a marginalist comprehension of the competition process, in which the atomism of participants of the market is the main characteristic. However, we can alternatively identify (as does Machado (2017)) that the difference between a price-taker or price-maker country (for a specific commodity) depends on a country's capacity to respond to world demand for the commodity with lower costs than the other countries. This second definition is the one that interests to purposes of the present paper.

[10] We avoid here the problem of overdetermination in the price-taker economy by introducing only one tradable commodity. In contrast, if this economy operated with more than one tradable commodity, the price of these commodities, given internationally, would allow for uniformization of the profit rate only by a fluke (Baldone; Steedman, 1999).

[11] The case against the conventional determination of the exchange rate by (absolute) Purchasing Power Parity is a well-established empirical result in economics (see, for instance, Engel, 2014).

[12] See Lavoie (2000b), and McCallum et al. (1996)

states that the real exchange rate is determined by monetary factors, subject to manipulation of public policy. This has important implications in the framework proposed in this chapter because the real exchange rate turns out to be a key determinant of income distribution.

Hence, the price equation of commodity 1 determines the normal profit rate given the money wage rate, the nominal exchange rate, international prices, and technical coefficients. From equation 2.3 we can derive the expression for the normal profit rate (r^*), as seen in the equation below.

$$(1 + r^*) = \frac{p_1 - wl_1}{a_1 p_1 + a_m p_m} \qquad [2.7]$$

By substituting p_1 per ep_1^*, and rearranging, we obtain equation 2.8. Note that p_m^* stands for the international price of the input m.

$$(1 + r^*) = \frac{p_1^* - \frac{w}{e} l_1}{a_1 p_1^* + a_m p_m^*} \qquad [2.8]$$

Capitalist competition leads to the convergence of profit rates between the two sectors. Hence, the profit rate in the non-tradable sector follows the rate established in the tradable sector.[13] [14] In other words, the classical process of profit rate convergence through competition takes place.[15]

As an illustration, consider that a nominal exchange rate devaluation rises prices in the tradable sector, leading to a persistently higher profit rate. In this case, there would be a tendency of migration of capitals from the non-tradable sector towards the tradable one. As a consequence, production in the non-tradable sector does not follow the pace of demand increases, which makes the market price for this good larger than its former normal price (that is, the normal price observed *before* the change in the normal profit rate due to the devaluation). This discrepancy persists until the profit rate obtained with

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[13] A similar process was described in the previous section in Furtado (1963)'s discussion on the effect of export prices of agricultural commodities over the land rent in non-exporting crops.

[14] Likewise, the authors of the Scandinavian model state that profit rates in tradable and non-tradable sectors either equalize or maintain a normal relationship in the long term. In other words, even if the two profit rates differ, the difference is must be stable. The adjustment mechanism proposed in this model is the change in wages. Thus, money wages absorb any price increase or productivity growth in the tradable sector, keeping its profit rate constant. In the non-tradable sector, a constant profit rate implies that wage increases that exceed productivity growth are passed through into prices. Aukrust (1977); Edgren et al. (1969, 1973)

[15] See, for instance, Garegnani (1990), Eatwell (1982) and Shaikh (2016, p. 259-326).

commodity 2 approaches the new normal profit rate determined in the production of commodity 1.[16]

Equation 2.8 reveals an inverse relationship between the normal profit rate and the ratio between money wages and the nominal exchange rate.[17] Moreover, as the international price of commodity 1 rises, the normal profit rate increases. In the absence of other changes, the higher profit rate also implies an increase in the price of commodity 2, as convergence takes place.

2.3.2 Inflation

To study inflation in this economy, we must check how prices change in time, outside of long-period positions. Let us assume that technical coefficients remain constant, but prices and distributive variables can change. So, we can rewrite the expressions for prices with a time index, as follows below.

$$p_1^t = (a_1 p_1^{t-1} + a_m p_m^{t-1})(1 + r^t) + w^{t-1} l_1 \quad [2.9]$$

$$p_2^t = (a_2 p_1^{t-1} + a_\mu p_\mu^{t-1})(1 + r^{t-1}) + w^{t-1} l_2 \quad [2.10]$$

$$p_1^t = e^t p_1^{*,t} \quad [2.11]$$

Inputs cost follow its prices as at the beginning of the period of production. Likewise, the wage rate is fixed at the beginning of the production period, despite being paid in the end. In contrast, the price of output is set at the moment of selling, which corresponds to the end of the production period. This time gap between the emergence of cost shocks and price adjustments allows inflation to interact with income distribution.

The profit rate in the tradable sector adjusts to the current price (given from the combination of international prices and exchange rate) and the production costs defined in the previous period. It is important to distinguish the movement in the *normal profit rate* (which concerns normal prices) from the transitory movements in the profit rate,

[16] Price adjustments do not necessarily require that migration of capitals occurs. The competition of potential entrants (and thus exits) across sectors can be conceived as sufficient for the transition of prices towards the new normal position (along the lines described by Sylos Labini, 1957). Besides, firm's willing to preserve their market-share would avoid not satisfying the effective demand. This firms tend to adjust production before any mismatch between supply and effective demand take place.

[17] Similar results are shown in Dvoskin and Feldman (2020) and Machado (2017).

described by what can be labeled as the *nominal profit rate*.[18]

Let us discuss this point in light of a short example. Consider a rise in the international price of commodity 1, which, given prices of other inputs and the money wage rate, leads to a higher normal profit rate. However, in the convergence process, the actual profit rate rises above the new normal profit rate before converging towards it. This overshooting happens because of the time lag between the immediate increase in the final price and the delayed increase in costs. Higher international prices for the tradable capital good instantaneously lead to a higher actual profit rate since selling price rose while costs remained fixed. This immediate effect is described in the equation 2.12, where π_1^t represents the rate of change in the price of 1 in the period t. Naturally, in line with the reasoning proposed, π_1^t is positive. The initial condition of normal prices held before the price increase coincides with the one represented by equation 2.7, and could be obtained by setting $\pi_1^t = 0$ in equation 2.12.

$$(1 + r^t) = \frac{(1 + \pi_1^t)p_1^{t-1} - w^{t-1}l_1}{a_1 p_1^{t-1} + a_m p_m^{t-1}} \quad [2.12]$$

The same machine, however, consists in part of the production costs. As a consequence, the total production cost relevant for commodities sold in the following period $(t+1)$ also increases after the rise in p_1. This process reduces the actual profit rate for the following period, as shown in equation 2.13. This profit rate represents the new normal profit rate, thereby being consistent with the change in relative prices.

$$(1 + r^{t+1}) = \frac{p_1^{t-1}(1 + \pi_1^t) - w^{t-1}l_1}{a_1 p_1^{t-1}(1 + \pi_1^t) + a_m p_m^{t-1}} \quad [2.13]$$

It is easy to check that r^{t+1} is smaller than r^t, since the numerator remains the same while the denominator is larger than in period t. Even though, the level of the profit rate is still above the previous value.[19] Thus, the convergence process to a new normal profit rate includes an initial jump in the profit rate observed in this sector since the value of costs (which includes commodity 1) changes only one period after.

As argued above, competition leads to the convergence of the profit rate in the non-

[18] Here, the normal profit rate corresponds to the relevant value for what concerns income distribution since it takes the replacement costs of capital into account. What we called the actual profit rate could also be labeled as the nominal profit rate and is measured according to the historical costs of capital.

[19] Indeed, if we define the initial profit rate as r^{t-1}, we can calculate the difference $r^{t+1} - r^{t-1}$, obtaining:

tradable sector towards the profit rate in the tradable sector. However, this process is not instantaneous. As a simplification, we assume that the convergence across sectors takes only one period. Hence, the profit rate in the price formation of the non-tradable sector is lagged in one period, differently from what happens in the tradable sector. In other words, the profit rate that affects prices of commodity 2 in t is the one obtained in the tradable sector in period $t-1$. It is reasonable to further assume that the profit rate in the non-tradable sector follows the normal profit rate determined in the tradable sector in the previous period. Introducing this assumption avoids that the transitory overshooting observed in the *nominal* profit rate of the tradable sector affects the profit rate in the other sector.

These equations allow us to describe different channels through which shocks in international prices and the exchange rate affect domestic prices. First, the domestic prices of tradable commodities are directly increased price abroad rise or the exchange rate devaluates. This direct channel is associated with competition and contestability since domestic goods present some degree of substitutability with goods produced abroad. Second, the increase in production costs due to higher prices of the tradable machine and imported inputs leads to higher prices in the non-tradable sector. Finally, a persistent increase in the profit rate (caused by a change in external conditions) leads to an increase in the prices of the non-tradable sector. This distributive channel builds on capitalist competition and the role of the tradable sector in determining distribution. An exchange rate devaluation triggers all these channels. Domestic factors are also taken into account since a rise in money wages leads to higher relative price for commodity 2.

2.3.3 Exchange rate devaluation

As shown elsewhere,[20] for given international prices, income distribution changes when the relation between nominal exchange rate and money wages change. Thus, a devaluation of the exchange rate with respect to money wages leads to a higher normal

$$\begin{aligned} r^{t+1} - r^{t-1} = & p_1^{t-1}\left[\frac{(1+\pi_1^t)}{a_1 p_1^{t-1}(1+\pi_1^t) + a_m p_m^{t-1}} - \frac{1}{a_1 p_1^{t-1} + a_m p_m^{t-1}}\right] + \\ & - w^{t-1} l_1 \left[\frac{1}{a_1 p_1^{t-1}(1+\pi_1^t) + a_m p_m^{t-1}} - \frac{1}{a_1 p_1^{t-1} + a_m p_m^{t-1}}\right] \end{aligned}$$

Note that the term within the first pair of brackets is positive, and the term within the second pair of brackets is negative, which implies the expression must be positive. We are considering the economically relevant case in which both profit rates are larger than zero and smaller than the maximum profit rate.

20 See, for instance, Metcalfe and Steedman (1981); Steedman (1999)

profit rate. This section discusses how a nominal devaluation affects costs and final prices and distribution before normal positions are achieved. From now on, by exchange rate devaluation, we intend a nominal devaluation, while money wages and foreign prices remain constant unless stated differently.

In this context, a permanent devaluation of the exchange rate has an instantaneous impact on inflation through a proportional increase in the domestic price of commodity 1. Let us consider we depart from an initial situation of normal prices corresponding to period $t-1$ and that the exchange rate shock occurs in period t, so that $\hat{e}^t > 0$. The price of commodity 1 is immediately affected: $p_1^t = (1+\hat{e}^t)p_1^{t-1}$. As discussed above, the higher price of commodity 1 leads to a rise in the profit rate in tradable sector. However, in the case of an exchange rate devaluation, this effect is different from the case of a pure increase in the international price of 1. Now, the domestic price of imported inputs (m, μ) also raises proportionally so that the impact on the profit rate is smaller than in the previous case.

A devaluation also increases production costs in the non-tradable sector due to the rise in the price of the tradable machine and the price – measured in domestic currency – of the non-competing imports. Hence, the price of commodity 2 will include the higher production costs in the following period , as in the expression below. Finally, from the period $t+1$ on, the price of commodity 2 rises also because the economy approaches a higher normal profit rate associated with the exchange rate devaluation. Note that unchanged variables keep the initial time index $(t-1)$, shedding light on the exchange rate devaluation effect. Note also that the term $(1+\hat{e}^t)$ that would multiply the value of the circulating capital cancels with the same term that multiplies the circulating capital of commodity 1 in the denominator of the profit rate.

$$p_2^{t+1} = (a_2 p_1^{t-1} + a_\mu p_\mu^{t-1}) \left[\frac{p_1^{t-1}(1+\hat{e}^t) - w^{t-1} l_1}{a_1 p_1^{t-1} + a_m p_m^{t-1}} \right] + w^{t-1} l_2$$

In the absence of further shocks, the economy stabilizes with a higher level of prices, higher profit rate, and lower real wages. The relative price of commodity 2 with respect to commodity 1 is lower after the adjustment process. We can derive this result in the following expressions. The first equation expresses the price of commodity one in period $t+1$. Since we are focusing on a one-period shock, the price is the same as in period t.

$$p_1^{t+1} = p_1^{t-1}(1+\hat{e}^t)$$

The relative price of commodity 2 with respect to 1 before (that is, period $t-1$) and after adjusting to the devaluation (completed in $t+1$) is expressed in the equations below. As expected, a lower relative price of 2 is associated with a lower ratio between the money wage rate and the price of commodity 1 — which could be interpreted as the real wage in terms of commodity 1.

$$\frac{p_2^{t-1}}{p_1^{t-1}} = (a_2 p_1^{t-1} + a_\mu p_\mu^{t-1}) \left(\frac{1 - \frac{w^{t-1}}{p_1^{t-1}} l_1}{a_1 p_1^{t-1} + a_m p_m^{t-1}} \right) + \frac{w^{t-1}}{p_1^{t-1}} l_2 \qquad [2.14]$$

$$\frac{p_2^{t+1}}{p_1^{t+1}} = [a_2 p_1^{t-1} + a_\mu p_\mu^{t-1}] \left(\frac{1 - \frac{w^{t-1}}{p_1^{t-1}(1+\hat{e}^t)} l_1}{a_1 p_1^{t-1} + a_m p_m^{t-1}} \right) + \frac{w^{t-1}}{p_1^{t-1}(1+\hat{e}^t)} l_2 \qquad [2.15]$$

If workers react to the rise in prices by asking for higher money wages, there is a further step to be discussed. Workers react to the fall in real wage in terms of the consumption good, by bargaining for an increase in money wages. The capacity of workers to obtain the desired wage rate depends on their bargaining power, determined by political and institutional features and by the conditions in the labor market (as the unemployment rate).

If, for instance, the rate of increase in money wages corresponds to a constant (and incomplete) proportion of the rate of the price increase in consumption good's price, the purchasing power of workers will partially recover from the initial shock. In the following period, however, the money wage increase is passed through into the price of commodity 2. This process can repeat for several rounds of adjustment of prices and money wages. However, as long as the reaction of money wages to the price increase is incomplete, the money wage rate and the price level will converge to a stable position in the absence of further changes in the nominal exchange rate. In this case, workers still obtain a lower real wage than before the shock, but higher than if they had not reacted.[21]

Let us consider an extreme case in which the ratio w/p_1 recovers completely from the initial shock. This situation arises when the accumulated rate of increase in money wages is equal to the rate of exchange rate devaluation after all adjustments. In this case,

[21] Even though it is conceivable that money wages keep rising till the real wage rate becomes larger than the previous one, it is not expected to obtain this outcome in an inflationary process triggered by an external shock. If workers were dissatisfied with real wages even before the shocks, they would have raised wage demands in the first place, provoking a standard conflicting claims inflation.

we return to the original relative prices with a higher level of prices and a higher nominal exchange rate. It is easy to see in equation 2.15 that if the money wage rate increases at the same rate as the exchange rate devaluation, we will obtain the same relative prices seen in equation 2.14.

The analysis advanced in the last paragraphs describes the interaction between distributive variables and relative prices after a permanent shock in the exchange rate. The shock can activate a temporary inflationary process as workers pressure for increases in money wages. Subsequent devaluations can generate a persistent inflationary process in a wage-exchange rate spiral.

The relations described in detail here are the basis of the model presented in section 2.4.

2.3.4 Price of non-tradable commodity

The non-tradable commodity (commodity 2) is the only consumption good. Workers consider its price in wage bargaining. The price of 2 varies with labor and input costs. While the former depends on the wage rate and the labor coefficient, the latter is determined by technical coefficients, foreign prices, and the nominal exchange rate. As seen in equation 2.10, the price of 2 also varies with the profit rate determined in the tradable sector. Although temporary shocks in prices and costs may deviate profit rates across sectors, competition leads to convergence. It has been argued that this process of gravitation through capital mobility can happen under quite general conditions (Bellino and Serrano, 2018; Garegnani, 1990). Henceforth, we assume the profit rate obtained in the production of commodity 2 follows the normal profit rate of 1 (that is, the one consistent with replacement costs of capital in the production of 1). Then, we can derive the dynamics of prices of commodity 2 by substituting the normal profit rate (assumed to hold in period $t-1$), given in equation 2.7, in the price equation of 2. Following this procedure, we obtain the expression that follows below.

$$p_2^t = (a_2 p_1^{t-1} + a_\mu p_\mu^{t-1}) \left(\frac{p_1^{t-1} - w^{t-1} l_1}{a_1 p_1^{t-1} + a_m p_m^{t-1}} \right) + w^{t-1} l_2 \qquad [2.16]$$

Since prices of commodity 1 and inputs m and μ are determined in the international market, we can substitute each of these terms by its correspondent international price multiplied by the exchange rate. Thus, we obtain:

$$p_2^t = (a_2 e^{t-1} p_1^{*,t-1} + a_\mu e^{t-1} p_\mu^{*,t-1}) \left(\frac{e^{t-1} p_1^{*,t-1} - w^{t-1} l_1}{a_1 e^{t-1} p_1^{*,t-1} + a_m e^{t-1} p_m^{*,t-1}} \right) + w^{t-1} l_2 \qquad [2.17]$$

Rearranging and canceling e when possible gives us equation 2.18.

$$p_2^t = \left(\frac{a_2 p_1^{*,t-1} + a_\mu p_\mu^{*,t-1}}{a_1 p_1^{*,t-1} + a_m p_m^{*,t-1}} \right) e^{t-1} p_1^{*,t-1} + \left(l_2 - l_1 \frac{a_2 p_1^{*,t-1} + a_\mu p_\mu^{*,t-1}}{a_1 p_1^{*,t-1} + a_m p_m^{*,t-1}} \right) w^{t-1} \qquad [2.18]$$

For simplicity, we can rewrite 2.18 as in equation 2.19, collapsing the two terms within parenthesis in Φ_1 and Φ_2. Introducing the assumption that international prices are constant, we get that these terms must also be constant in time. The same holds for the international price of commodity 1. Thus, we can withdraw the time index of this variable. Consequently, changes in the price of 2 are explained by changes in the exchange rate and in money wages.

$$p_2^t = \Phi_1 e^{t-1} p_1^* + \Phi_2 w^{t-1} \qquad [2.19]$$

Note that Φ_1 corresponds to the ratio between circulating capital inputs to the production of commodity 2 to the same variable for commodity 1. In the case of a price-taker open economy with one tradable capital good, this ratio can be expressed in terms of international prices. It is thus exogenous to the domestic economy. If the production of 2 requires a larger value of capital input, then $\Phi_1 > 1$, which implies that the price of 2 responds more than proportionally to an increase in the exchange rate.

The sign of the Φ_2 depends on the relative proportions of labor to circulating capital of each industry. This term is positive if production of commodity two has a higher ratio between labor input and circulating capital, *given the prices* p_1^*, p_m^*, p_μ^*.[22] We assume this term is positive. This assumption is justified because, in general, non-tradable industries tend to have a smaller capital-labor ratio than tradable industries.[23] While tradable

[22] It is easy to check this, since $\Phi_2 > 0$ if and only if $\frac{l_2}{a_2 p_1^* + a_\mu p_\mu^*} > \frac{l_1}{a_1 p_1^* + a_m p_m^*}$, which corresponds to the interpretation stated in the text.

[23] These capital-labor ratios depend on the prices of 1, m and μ. Mathematically, Φ_2 may be negative depending on these prices. However, if this is the case, an increase in money wages would reduce the price of commodity 2. The positive impact in the form of additional labor costs would be more than offset by the decrease in the profit rate. We abstract from this possibility, assuming that Φ_2 is positive. Although a negative Φ_2 is theoretically possible, it seems less plausible once we acknowledge the stylized facts

industries include manufacturing and dynamic industries, non-tradable industries include services, among other sectors.[24] In addition, it is expected that an increase in wages tends to increase prices in non-tradable industries (what can only happen if this term is positive). Note that this term contains two effects of wages in the price of commodity 2. The first one is direct, due to the labor input in the production of commodity 2. For this reason, a wage increase affects production costs in sector 2, which causes a price increase in the subsequent period. The second effect relates to the negative impact of a wage increase on the profit rate in the production of commodity 1. By means of this channel, a wage increase reduces the price of 2. Altogether, the outcome depends on which channel is the strongest. Finally, we can discuss the case in which the combined effect is null, what happens when $\Phi_2 = 0$. In this case, both industries present the same capital-labor ratio. For this reason, changes in distributive variables (either wage rate or profit rate) do not affect relative prices.[25] Note that if the term discussed here is null, the price of 2 moves proportionally with the price of 1, maintaining a constant relation between them.

Let us further assume that international relative prices remain stable as well as the international price level. Consequently, the price of commodity 2 varies with changes in the exchange rate and money wages. In this case, we can describe in equation 2.20 the rate of change in the price of commodity two. This expression comes from the rate of change in the price of commodity 2 (as in equation 2.19). Since the international price level is assumed stable, $\pi_1^* = 0$, international inflation is not included in equation 2.20.

$$\pi_2^t = \phi_1^t \hat{e}^{t-1} + \phi_2^t \hat{w}^{t-1} \qquad [2.20]$$

mentioned in the text. Finally, since foreign prices are exogenous, we can also abstract from changes in the value or sign of Φ_2.

24 Baumol (1967) stressed the tendency for increasing relative prices of services with respect to manufacturing goods due to the difficulty to reduce labor content in services. Besides, Aukrust (1977), Edgren et al. (1969), and Eatwell et al. (1974) used the fact that tradable industries tend to present higher productivity growth when analyzing inflation. However, the authors do not clearly distinguish if higher productivity results from reductions either in labor or capital input.

25 This is a known property arising from the analysis of price equations with uniform profit rate. As pointed by Sraffa (1960, p. 12), "[t]he key to the movement of relative prices consequent upon a change in the wage lies in the inequality of the proportion in which labour and means of production are employed in the various industries. It is clear that if the proportion were the same in all industries no price-changes could ensue, however great was the diversity of the commodity-composition of the means of production in different industries". This property is preserved in a small open economy with a tradable capital good (Steedman, 1999).

where

$$\phi_1^t = \frac{\Phi_1 e^{t-2} p_1^*}{\Phi_1 e^{t-2} p_1^* + \Phi_2 w^{t-2}}$$

and $\phi_2^t = 1 - \phi_1^t$.

Note that the weights denoted by ϕ_1 and ϕ_2 vary in time. Clearly, their value is kept positive and smaller than one.[26] Since international prices are assumed constant, Φ_1 and Φ_2 remain constant. Thus, changes in ϕ_1 and ϕ_2 follow changes in the exchange rate and money wages.

Finally, equation 2.20 reveals that the impact of cost shocks on the price of commodity 2 is delayed in one period. This property emerges from the definition of production prices according to historical costs. Hence, there is a delay in the pass-through of costs into prices, which is a desirable property in a conflict inflation model, as discussed in the course of this chapter.

2.3.5 Real exchange rate

Analyzing the interactions between inflation and the real exchange rate is important because monetary authorities possibly target a value for the real exchange rate. Such a policy choice can be associated with different objectives. In some cases, it aims to stimulate exports in order to keep an equilibrium in the balance of payments (as in Vera 2010, Blecker 2011, Vernengo and Perry 2018). However, this requires that the Marshall-Lerner condition holds, which may not occur. Alternatively, a targeted real exchange rate may be an instrument of structural change in support of industrialization (as in new-structuralist views such as Bresser-Pereira 2008). Finally, this policy can derive from distributive objectives, once a devaluation of the real exchange rate implies a higher profit rate and a lower real wage rate, as in the model discussed here.[27]

The real exchange rate is usually defined as the nominal exchange rate adjusted by domestic and foreign price levels (Chinn 2018), as described in the equation 2.21.

$$e_R^t = \frac{e_t p_t^*}{p_t} \qquad [2.21]$$

[26] Note that if, in contrast with our assumptions, we had that $\left(l_2 - l_1 \frac{a_2 p_1^* + a_\mu p_\mu^*}{a_1 p_1^* + a_m p_m^*}\right) = 0$, then we would obtain $\phi_1 = 1$ and $\phi_2 = 0$, which is compatible with the description of this particular case (see footnote 25). Hence, by assuming that $\left(l_2 - l_1 \frac{a_2 p_1^* + a_\mu p_\mu^*}{a_1 p_1^* + a_m p_m^*}\right) > 0$ we also set that the weights ϕ_1, ϕ_2 must remain between zero and one.

[27] See also (Dvoskin et al., 2018).

In this case, nominal devaluations only succeed in devaluating the real exchange rate if an increase in domestic prices does not completely offset them. Both foreign and domestic price levels include prices of tradable and non-tradable commodities. Thus, the rate of change in real exchange rate depends on the change in the nominal exchange rate ($\hat{e}$) and the rate of change of tradable and non-tradable prices in both domestic and foreign economies. Equation 2.22 describes a linear approximation of the change in the real exchange rate.[28] Note that π stands for domestic inflation while π^* stands for foreign prices inflation.

$$\hat{e}_R^t = \hat{e}_t + \pi_t^* - \pi_t \qquad [2.22]$$

Under the assumption of a price-taker open economy, tradable prices are determined abroad. Its value in domestic currency varies proportionally with the nominal exchange rate. The increase of tradable prices partially offsets the impact of a nominal devaluation on the real exchange rate. Therefore, the performance of non-tradable prices is crucial for the real exchange rate.

The price of the non-tradable commodity depends on the costs of the tradable commodity and the wage rate. As the first is already given, the second variable obtains more relevance in determining the real exchange rate. Thus, the process according to which workers react to nominal exchange rate devaluations by asking wage increase to protect real wages can offset the impact of the nominal devaluation on the real exchange rate. If monetary authorities target a value for the real exchange rate, this leads to further nominal devaluations. The economy can experience repeated nominal devaluations followed by money wage increases, generating chronic inflation in a money wages-exchange rate spiral. Nevertheless, as both sides are unsuccessful in achieving their goals, they tend to moderate their claims (i.e., workers moderate money wage demands, while monetary authorities accept a partially smaller real exchange rate devaluation to avoid inflation). If this happens, the economy converges to a stable position.

Given technical coefficients, the domestic level of prices is determined by international prices, the nominal exchange rate, and the wage rate. As a consequence, the real exchange rate will be proportional to the ratio of international prices as

[28] This approximation is required because we are reasoning in terms of discrete-time. The actual rate of change of the real exchange rate is given by: $\hat{e}_R^t = \frac{\hat{e}_t + \pi_t^* - \pi_t + \hat{e}_t \pi_t^*}{1 + \pi_t}$.

measured in the domestic currency to money wages. That is the relevant real exchange rate for the analysis of distributive conflict. Indeed, other works using similar price equations in the open economy discuss the changes in specialization, relative prices, distribution provoked by changes in the ratio between exchange rate and money wages (Dvoskin and Feldman, 2020; Dvoskin et al., 2018; Machado, 2017). For this reason, let us introduce the variable q, whose definition is presented in equation 2.23 as an equivalent to the real exchange rate, useful for the analysis in the remaining of this chapter. Note that q does not correspond exactly to the real exchange rate as usually defined, but both are certainly affected by the same variables and move in the same direction. We show that in the appendix B. The value of q and its relation with income distribution are defined for given international price level and international relative prices.

$$q_t = \frac{e_t}{w_t} \qquad [2.23]$$

The rate of change of q is approximately expressed in the equation below.[29]

$$\hat{q}_t = \hat{e} - \hat{w}_t \qquad [2.24]$$

The value of q is inversely related to the real wage in terms of commodity 2. By using equation 2.19 as a description of the price of commodity 2, we get that the real wage in period t can be written as follows:

$$w_R^t = \frac{w_t}{\Phi_1 e_{t-1} p_1^* + \Phi_2 w_{t-1}} \qquad [2.25]$$

Thus, by dividing both the numerator and denominator of the fraction in the right-hand side by w_{t-1}, we obtain equation 2.26.

29 As before, this is a linear approximation of the expression:

$$\hat{q}_t = \frac{\hat{e}_t - \hat{w}_t}{1 + \hat{w}_t}$$

$$w_R^t = \frac{1 + \hat{w}_t}{\Phi_1 q_{t-1} p_1^* + \Phi_2} \quad [2.26]$$

The last equation finally gives us a relation between the real wage rate and q, given technical coefficients and international prices. Note also that a higher rate of growth of money wages implies a larger value for real wages. This outcome is consistent with historical cost pricing and the notion of conflict inflation itself, as emphasized by Tarling and Wilkinson (1985), Pivetti (1991), Stirati (2001), Serrano (2010).

2.4 Quantities, Unemployment and Conflict

In the last section, I have discussed the dynamics of the price level and relative prices following supply shocks. Although the section presented different possible results, the distributive conflict still needs proper treatment. We cannot account for conflict without introducing variables such as output and employment in the analysis. As discussed above, besides political and institutional factors, the unemployment rate affects affects the bargaining power of workers. Hence, employment affects the rate of change of money wages and, thus, inflation. That makes the employment rate relevant to explain inflation and the distributive outcomes. Therefore, in this section, we examine the interaction between inflation and conflict given the effect employment on wage bargaining.

We consider output, employment and growth to be determined by the level and growth of effective demand in line with the demand-led growth tradition. The view according to which output is determined by demand both in the short and long run can be combined with conflict inflation. Indeed, the integration of these two analytical objects is frequent in Post-Keynesian economics.[30]

Since the potential output is endogenous in the long run, the evolution of productive capacity adjusts to the growth of demand. The perspective that output level and growth are determined by effective demand acknowledges the existence of spare capacity and labor force unemployment as recurrent conditions of capitalist economies. In this case, inflation, as caused by excess of aggregate demand, would be considered a less frequent phenomenon. That explains why the coexistence of positive inflation rates with unemployment and spare capacity was often reclaimed as an evidence in favor of cost-inflation interpretations (Morlin, 2021). In addition, it is considered that companies operate with planned idle capacity and are therefore able to meet (to some extent) unexpected demand expansions (Ciccone, 2000, 2011; Steindl, 1952). Thus, the excess of aggregate demand can provide an explanation to temporary raises in prices only when it is greater than full capacity output. Inflation due to excess of aggregate demand occurs when aggregate demand exceeds the potential output, so that a rise in prices adjusts the real value of aggregate demand to the short-term restriction imposed by potential output. However, demand causes are generally not an explanation for inflation, which is thus mainly a cost-push phenomenon. According to the demand-led

[30] Many of these analyses are summarized in section 2.2. However, as I argued, the explicit connection between distributive conflict and inflation is limited in open economy models.

growth perspective, aggregate supply follows the pace of demand growth. Thus, even though excess of demand may be inflationary in the short term, in general, this effect is not sustained in a longer period, when production and the capacity to produce goods and services grows in line with demand, dissipating the inflationary pressure (Serrano, 2019). If supply can meet demand increases, the inflationary effect of a situation of excessive demand cannot last.

2.4.1 Output and employment

After this introduction, we can set the base of the model for introducing quantities into our analysis of inflation in the open economy. The model represents a small open economy whose output is composed of two commodities, one tradable another non-tradable, produced by means of domestic and non-competing imported inputs. As it is already clear in the paper, commodity 1 is an input and a tradable good. Commodity 2 is non-tradable, and it is a consumption good (and it is not an input to any production). Moreover, we have two non-competing imported commodities, which are inputs to commodities one and two. The analysis solely accounts for circulating capital. We also abstract from public expenditure among the determinants of aggregate demand.

Let us start by introducing the magnitudes Q_1 and Q_2, which correspond to the quantity produced of commodities 1 and 2. Then, the gross value of output is expressed in equation 2.27. On the left-hand side, we have the nominal output. On the right-hand side, we show output composition according to the sum of the value of production of commodities 1 and 2. In turn, the left-hand side by means of the price equations of both commodities. Therefore, each circulating capital input and labor input appear in proportion to its technical coefficient in the production of the commodity that requires it, and to the quantity produced of the same commodity.

$$Q_1 p_1 + Q_2 p_2 = \{Q_1[(a_1 p_1 + a_m p_m)] + Q_2[(a_2 p_1 + a_\mu p_\mu)]\}(1+r) + \{[Q_1 l_1 + Q_2 l_2]\}w \tag{2.27}$$

Rearranging equation 2.27, we can obtain equation 2.28. The first term within braces in equation 2.28 corresponds to the Intermediate Consumption in this economy, being composed of domestic produced commodity 1 and non-competing imports m and μ. The second term corresponds to the mass of profits. The third term gives us the wage bill.

$$
\begin{aligned}
Q_1p_1 + Q_2p_2 = &\{Q_1[(a_1p_1 + a_mp_m)] + Q_2[(a_2p_1 + a_\mu p_\mu)]\}+ \\
&\{Q_1[(a_1p_1 + a_mp_m)] + Q_2[(a_2p_1 + a_\mu p_\mu)]\}r + \{[Q_1l_1 + Q_2l_2]\}w
\end{aligned} \qquad [2.28]
$$

By subtracting the Intermediate Consumption from the value of the gross product, we obtain the economy's output value, that is, the value-added product. It is straightforward that the output is equal to the sum of total profits and the wage bill. Therefore, the nominal output is equal to aggregate income.

$$
\begin{aligned}
Q_1p_1 + Q_2p_2 - &\{Q_1[(a_1p_1 + a_mp_m)] + Q_2[(a_2p_1 + a_\mu p_\mu)]\} = \\
&\{Q_1[(a_1p_1 + a_mp_m)] + Q_2[(a_2p_1 + a_\mu p_\mu)]\}r + \{[Q_1l_1 + Q_2l_2]\}w
\end{aligned} \qquad [2.29]
$$

In this case, the profit share (Π) is given by the ratio of total profits to aggregate income, as shown in equation 2.30.

$$
\Pi = \frac{\{Q_1[(a_1p_1 + a_mp_m)] + Q_2[(a_2p_1 + a_\mu p_\mu)]\}r}{\{Q_1[(a_1p_1 + a_mp_m)] + Q_2[(a_2p_1 + a_\mu p_\mu)]\}r + \{[Q_1l_1 + Q_2l_2]\}w} \qquad [2.30]
$$

In turn, the wage share ($1 - \Pi$) is described by the ratio of the wage bill to aggregate income, as in equation 2.31.

$$
1 - \Pi = \frac{\{[Q_1l_1 + Q_2l_2]\}w}{\{Q_1[(a_1p_1 + a_mp_m)] + Q_2[(a_2p_1 + a_\mu p_\mu)]\}r + \{[Q_1l_1 + Q_2l_2]\}w} \qquad [2.31]
$$

Even though these results may not seem particularly relevant, they clarify the connection between income distribution and the basic distributive variables introduced previously. As expected, equation 2.30 shows that the profit share increases with the profit rate. In contrast, equation 2.31 reveals that the wage share increases with the money wage rate and decreases with the profit rate. Income distribution may also vary due to changes in the technical coefficients of production. For instance, a higher requirement of capital in the production of either commodity 1 or 2 increases the profit share according to equation 2.30. However, we abstract from changes in technical coefficients to focus on the conflict inflation. Thus, we assume that changes in distribution are not large enough to affect the production techniques.

The aggregate supply in this economy is given by the total output (Y) plus imports (M). Note that imports are composed strictly of non-competing inputs (m, μ) required to produce commodities 1 and 2. Hence, imports of each input will be proportional to the production of each commodity. For this reason, imports are part of the intermediate consumption of this economy. Total uses of goods and services are given by imported Intermediate Consumption (IC_M — which corresponds to M), domestically produced Intermediate Consumption (IC_D), Consumption (C) and Exports (X). Thus, the equilibrium condition for the goods market is described by the equation below. Note that all variables in this equation are considered in nominal terms.

$$Y + M = X + IC_M + IC_D + C \quad [2.32]$$

Each commodity's production has a counterpart in one or more components of demand. As commodity 1 is exported and used as input to production, the total quantity of 1 must be equal to the sum of exports and domestic intermediate consumption, as in equation 2.33. Since commodity 2 is produced exclusively for consumption, its quantity is totally determined by aggregate consumption — as in 2.34. Finally, as stated above, imports correspond to the quantity of inputs imported, which are proportional to the production of commodities one and two. Thus, total imports, or imported intermediate consumption, is described by equation 2.35

We can formalize these lines as follows below:

$$Q_1 p_1 = X + IC_D \quad [2.33]$$

$$Q_2 p_2 = C \quad [2.34]$$

$$a_m Q_1 p_m + a_\mu Q_2 p_\mu = IC_M \quad [2.35]$$

A few further details can be introduced. Domestic intermediate consumption is proportional to the quantity produced of each commodity, as in the equation below.

$$a_1 Q_1 p_1 + a_2 Q_2 p_1 = IC_D \qquad [2.36]$$

Let us further assume that workers consume all their income. As a consequence, consumption is determined by the value of the wage bill, which corresponds to the wage rate times the total employment in the economy (denoted as L), as in 2.37.

$$C = wL \qquad [2.37]$$

The total employment is described by equation 2.38, depending on the quantity of each commodity and on each labor coefficient.

$$L = l_1 Q_1 + l_2 Q_2 \qquad [2.38]$$

Therefore, by substituting equation 2.37 in 2.38, we obtain an expression for the aggregate consumption, as in 2.39. Consumption is increasing in the wage rate and with the employment generated in each industry.

$$C = w(l_1 Q_1 + l_2 Q_2) \qquad [2.39]$$

In the equilibrium of goods market, $C = p_2 Q_2$. Thus,

$$Q_2 = \frac{C}{p_2} = \left(\frac{w_R l_1}{1 - w_R l_2} \right) Q_1 \qquad [2.40]$$

Here, w_R denotes the real wage rate, that is the wage rate divided by the price of commodity 2. Therefore, equation 2.40 determines Q_2 as a function of Q_1. Substituting this result in equation 2.36, we obtain equation 2.41. This expression determines domestic intermediate consumption as a function of Q_1. Note that both the quantity produced of commodity 2 and the IC_D depend on the quantity of commodity 1 and the real wage.

$$\frac{IC_D}{p_1} = a_1 Q_1 + a_2 \left(\frac{w_R l_1}{1 - w_R l_2} \right) Q_1 = \left[a_1 + a_2 \left(\frac{w_R l_1}{1 - w_R l_2} \right) \right] Q_1 \tag{2.41}$$

Plugging this last result in equation 2.33, we obtain 2.42.

$$Q_1 = \frac{X}{p_1} + \left[a_1 + a_2 \left(\frac{w_R l_1}{1 - w_R l_2} \right) \right] Q_1 \tag{2.42}$$

Denoting the real value of exports by χ and rearranging the former expression, we obtain:

$$Q_1 = \frac{\chi}{\left[1 - a_1 - a_2 \left(\frac{w_R l_1}{1 - w_R l_2} \right) \right]} \tag{2.43}$$

Equation 2.43 shows the quantity produced of commodity 1 is directly determined by the level of exports added of the multiplier effects generated by workers' consumption and intermediate consumption of production of both commodities. Given the technical coefficients, the value of Q_1 varies increasingly with changes in the level of exports and with changes in the real wage. By assumption, exports are the only autonomous expenditure in this small open economy. Thus, from the level of exports and their repercussions in consumption, we can get the aggregate production level.

Using these results, we can obtain the level of employment associated with this equilibrium. If we substitute 2.43 and 2.40 in the expression for the level of employment (equation 2.38) and rearranging, we obtain equation 2.44.[31] This equation expresses total employment as determined by the demand for labor in production, which, in turn, is determined by the level of aggregate demand.

$$L = \left\{ \frac{l_1}{1 - a_1 + w_R((-l_2)(1 - a_1) - a_2 l_1)} \right\} \chi \tag{2.44}$$

The denominator of the term within braces is positive. Otherwise either (i) the economy is not *viable*, that is, technical conditions are not sufficient for the self-reproduction of the economic system or; (ii) real wage is larger than the maximum

[31] The complete mathematical steps are in appendix A.

real wage admissible for this economy.[32]

Note that L varies positively with the real wage rate, and this variation increases with the real wage. As shown in equation 2.45, the derivative of L with respect to w_R is given in equation 2.45, which is positive and increasing in w_R.

$$\frac{dL}{dw_R} = \frac{l_1[(1-a_1)l_2 + a_2 l_1]\chi}{\{1 - a_1 - w_R[(1-a_1)l_2 + a_2 l_1]\}^2} \tag{2.45}$$

We can express the term within braces in equation 2.44 as a non-linear function of the real wage (denoted by $\Lambda(w_R)$), with given technical coefficients. Hence, we can rewrite the expression for the employment level as the product of this function and the level of exports, as follows in equation 2.46.

$$L = \Lambda(w_R)\chi \tag{2.46}$$

Note that Λ varies positively and increasingly with w_R.

Once we set the employment determination, we can define the unemployment rate. Unemployment rate (u) is given by $u = 1 - \frac{L}{N}$, where N stands for to the total labor force. Note that N entails an upper constrain to employment and, thus, to output. Hence, we must assume that $L < N$. According to this assumption, effective demand is not large enough to lead the economy towards full employment, which corresponds to the general condition of capitalist economies.

By substituting equation 2.46 in the definition of the unemployment rate, we get equation 2.47. Thereby, we can express the unemployment rate as a function of real wages and exports.

$$u = 1 - \left(\frac{\Lambda(w_R)\chi}{N}\right) \tag{2.47}$$

The demand for labor is expressed in equation 2.46. From this equation, we can obtain the following expression for the rate of growth of labor demand (denoted by g_L).

[32] These results are shown in appendix A.

$$g_L = \Lambda \widehat{\left(\frac{w}{p_2}\right)} + g_X + \Lambda \widehat{\left(\frac{w}{p_2}\right)} g_X \qquad [2.48]$$

Which can be approximated linearly by:

$$g_L = \Lambda \widehat{\left(\frac{w}{p_2}\right)} + g_X \qquad [2.49]$$

Naturally, for a constant real wage, the growth of labor demand is equal to the growth of exports ($g_L = g_X$).

2.4.2 Inflation, wages and exchange rate

Now, we are able to establish a relation between employment and money wage growth. This is approached in a similar way as in Rowthorn's (1977), and later employed by many authors (Dalziel, 1990, Cassetti, 2002, Hein and Stockhammer, 2010, Lavoie et al., 2002). In most of these models, workers target an income share expressed either in terms of the wage share or the profit share. For a constant labor productivity and composition of output, there is a direct correspondence between the wage share and real wage rate.[33] Hence, we can address this issue by introducing a target for the real wage (w^T). Real wage is directly connected with workers interest and is not subject to the effects of changes in the output composition.[34] Real wage is inversely related to the normal profit rate.

In a Classical-Keynesian perspective, real wage and normal profit rate are the meaningful variables for discussing distribution. Therefore, we introduce a target for the real wage (w^T) so that workers will push for wage increases according to the difference between the actual real wage and this target.

The rate of growth of money wages ($\hat{w}$) depends on the evolution of the price of commodity 2 (π_2). Changes in the cost of living affect wage negotiations, and often

[33] However, in a model in which workers target an income share, productivity growth would not affect the distributive conflict (*i.e.*, the degree of incompatibility between income claims of social classes, which, in Kaleckian models, can be measured by the difference between workers and capitalists targeted income shares). We expect, however, that a an increase in the growth rate of productivity relaxes the distributive conflict. Marglin and Schor (1991) and Glyn et al. (1991) exemplify this point by discussing the end of the Golden Age of capitalism. The authors argue that the slowdown in productivity growth exacerbated the distributive conflict in the end of the Golden Age, accelerating the rates of inflation in advanced capitalist economies.

[34] An increase in the output of the commodity with a larger labor input coefficient increases the wage-share, for a constant real wage rate. See equation 2.31.

indexation rules are included in labor agreements. However, indexation is assumed to be incomplete. α_1 is thus positive and smaller than 1. Real wages also vary according to workers' aspiration gap, *i.e.*, the difference between their targeted real wage and the actual real wage. α_2 expresses the sensibility of wage increases to the aspiration gap. α_2 therefore depends on institutional and political factors, as trade union membership, the structure of unions, labor legislation, and social rights.

We assume that workers' target (w^T) and their institutional bargaining power (expressed in the parameters α_1 and α_2) are fixed in the time horizon of the conflicting claims model. However, these parameters change in longer time horizons. Classical economists described how workers standard of living evolves according to customary factors (Stirati, 1994). In this view, periods of higher wages would thus increase the standard of living compatible with the notion of social subsistence wage. These effects certainly affect workers' perception about a fair income distribution, which is behind their real wage target.

Considering these effects, we can write equation 2.50.

$$\hat{w}^t = \alpha_1 \pi_2^{t-1} + \alpha_2 (w_R^T - w_R^{t-1}) \tag{2.50}$$

Thus, the rate of change of money wages is a function of the rate of change in the price of commodity two, workers' aspiration gap, and on α_1 and α_2 (assumed fixed). Equation 2.50 takes workers' target as given. Later on, we will allow for changes in workers' target, according to changes in the employment rate.

Let us introduce a rule of exchange rate devaluation. We assume that the monetary authorities follow a rule for changing the nominal exchange to pursue a target real exchange rate (q_T). Since there is a direct association between the real exchange rate and income distribution, this target can be associated with distributive purposes. Therefore, the rate of change in the exchange rate can be given by equation 2.51. This rule was introduced by Blecker (1989a, 2011).

$$\hat{e}^t = \lambda (q_T - q^{t-1}) \tag{2.51}$$

As we have shown, q and real wage rate are inversely related. Hence, we can express equation 2.51 in terms of a target for the real wage rate. In this case, the equation can be written as follows below. The target for the real wage corresponding to q_T is denoted as w_R^q.

$$\hat{e}^t = \lambda(w_R^{t-1} - w_R^q) \qquad [2.52]$$

Collecting the equations for inflation, money wages, and exchange rate, we obtain the following system:

$$\hat{w}^t = \alpha_1 \pi_2^{t-1} + \alpha_2(w_R^T - w_R^{t-1}) \qquad [2.53]$$

$$\pi_2^t = \phi_1^t \hat{e}^{t-1} + \phi_2^t \hat{w}^{t-1} \qquad [2.54]$$

$$\hat{e}^t = \lambda(w_R^{t-1} - w_R^q) \qquad [2.55]$$

We can rewrite the system in terms of real variables, restricting it to two equations describing real wages and real exchange rate.

The rate of change in real wages is defined as the difference between change in money wages and prices of commodity two: $\hat{w_R}^t = \hat{w}^t - \hat{p_2}^t$. Combining this definition with equation 2.50 gives us equation 2.56.

$$\hat{w_R}^t = -\pi_2^t + \alpha_1 \pi_2^{t-1} + \alpha_2(w_R^T - w_R^{t-1}) \qquad [2.56]$$

The rate of change in the variable q is described in equation 2.24, rewritten below.

$$\hat{q}^t = \hat{e}^t - \hat{w}^t \qquad [2.57]$$

By substituting the expression for the rate of change in the exchange rate given in equation 2.55, we obtain equation 2.58. Together, equations 2.56 and 2.58 form the basis of the dynamic system.

$$\hat{q}^t = \lambda(w_R^{t-1} - w_R^q) - \hat{w}^t \qquad [2.58]$$

2.4.3 Equilibrium of the dynamic system

The dynamic system stabilizes when both real wages and the real exchange rate stop adjusting. In other words, when both equations 2.56 and 2.58 are equal to zero. The equilibrium values of this dynamic system, which corresponds to the short run equilibrium of the conflicting claims model, are denoted by the superscript **.

From equation 2.57, we obtain that $\hat{w} = \hat{e}$ in the equilibrium of the dynamics system, since the level of q must remain stable. Besides, a constant real wage requires that $\hat{w} = \pi_2$. By setting $\hat{w_R} = 0$ in equation 2.56, we can obtain the equilibrium value for the rate of change in prices of commodity two, expressed below. That expression also gives us the results for the rate of change of the nominal exchange rate and the rate of increase in money wages.

In the absence of changes in international prices, the rate of change of prices of sectors 1 and 2 is the same, since the nominal exchange rate and money wages rise at the same rate (in the dynamic equilibrium). As a consequence, the inflation rate is given by the following expression — that is, the same expression as the one for the rate of growth of money wages, rate of change in the exchange rate, and rate of change in prices in each industry (1,2). In other words, in the equilibrium, $\pi_2 = \pi = \hat{w}$. The equilibrium inflation rate is described by the equation below.

$$\pi^{**} = \frac{\lambda\alpha_2(w_R^T - w_R^q)}{\alpha_2 + \lambda(1-\alpha_1)} \qquad [2.59]$$

We can rewrite it as follows.

$$\pi^{**} = \frac{w_R^T - w_R^q}{\frac{1}{\lambda} + \frac{(1-\alpha_1)}{\alpha_2}} \qquad [2.60]$$

In turn, equilibrium real wage rate is described by the equation below.

$$w_R^{**} = \frac{\alpha_2 w_R^T + \lambda(1-\alpha_1)w_R^q}{\alpha_2 + \lambda(1-\alpha_1)} \qquad [2.61]$$

Similarly to other conflicting claim models, equilibrium real wage is an weighted average of the two different targeted real wage. That equilibrium value is sensitive to changes in the parameters α_1, α_2, and λ. For instance, if wage indexation parameter (α_1) increases, then equilibrium real wage gets closer to workers' target. The same result is obtained if the parameter related to workers' bargaining power increases. In turn, if monetary authorities accelerate the speed of adjustment of the nominal exchange rate (*i.e.*, λ increases), then the equilibrium real exchange rate will come closer to its targeted value w_R^q.

If inflation emerges from wage claims (a greater w_R^T) or the strengthening of workers position (as a greater α_2), a higher inflation rate is associated with a larger value for the equilibrium real wage rate. This outcome is usually obtained in conflict inflation models.

Finally, a larger real wage rate implies a loss in capitalist's share in distribution. It follows, thus, that a higher equilibrium real wage and a a lower equilibrium q are associated with a lower profit rate and lower profit-share.

Dynamic equilibrium with endogenous worker's claim

Let us now consider the case in which workers' income claim is affected by the labor market. Previous conflicting claim models have set workers' wage target as dependent of changes in the rate of unemployment (Cassetti, 2002; Lavoie, 2014). As shown in section 2.4.1, persistent changes in unemployment rate depend on the difference between the growth rate of exports g_X and the growth rate of labor force g_L. Hence, we can define that workers' target for the real wage depends on an autonomous component, reflecting institutional and political factors, and a second term that expresses the effect of changes in the unemployment rate.

$$w_R^T = \theta_0 + \theta_1(g_X - g_L) \qquad [2.62]$$

Now we can plug equation 2.62 in the equilibrium results obtained above. Equilibrium real wage rate is now given by:

$$w_R^{**} = \frac{\alpha_2[\theta_0 + \theta_1(g_X - g_L)] + \lambda(1-\alpha_1)w_R^q}{\alpha_2 + \lambda(1-\alpha_1)} \qquad [2.63]$$

The result for the inflation rate is given by:

$$\pi^{**} = \frac{[\theta_0 + \theta_1(g_X - g_L)] - w_R^q}{\frac{1}{\lambda} + \frac{(1-\alpha_1)}{\alpha_2}} \qquad [2.64]$$

Therefore, a situation of increasing unemployment will reduce both the equilibrium real wage and inflation. In contrast, falling unemployment implies an increase in both the equilibrium real wage and inflation.

Closure in the aspiration gap and long period position

Rowthorn (1977, p. 217) defines the aspiration gap as the difference between the target share in income and the actual income shares resulting from the processes of wage bargaining and inflation. In the model presented here, workers' aspiration gap corresponds to the difference between workers' targeted real wage (w_R^T) and the equilibrium real wage (w_R^{**}). Capitalists' aspiration gap can be described by the difference between the targeted real wage coming from monetary authorities' target for the ratio between nominal exchange rate and money wages (w_R^q) and the equilibrium real wage (w_R^{**}). A positive aspiration gap is the fundamental cause of conflicting claims inflation (Lavoie, 2014; Rowthorn, 1977). If both sides give up on claiming for a real wage different than the one resulting from the process of bargaining and inflation, the aspiration gap goes to zero. In that case, inflation rate is also zero in the absence of cost shocks. This theoretical scenario allow us to describe the long period position associated with the distributive equilibrium.

We do not expect the aspiration gap to persist over time. Hence, conflict inflation is treated as a short period phenomenon, tending to dissipate in the absence of shocks in costs or employment (which affect the workers' target).[35] The equilibrium associated with the closure of the aspiration gaps is described by the real wage expressed in equation 2.63 and stability in the price level. Thus, we can obtain the equilibrium ratio between nominal exchange rate and money wages (q).

As argued before, the result for q is inversely related to the real wage rate (see section 2.3.5). Hence, we obtain the equilibrium for the ratio between the exchange rate and money wages from the relation between the real exchange rate and the real wage, as

[35] Naturally this is a theoretical possibility not accomplished in the real world as different sources of disequilibrium continuously emerge. Still, it is worth exploring this scenario to fully understand the outcomes of the model.

defined previously in equation 2.26.[36]

$$q^{**} = \frac{1}{\Phi_1 p_1^* w_R^{**}} - \frac{\Phi_2}{\Phi_1 p_1^*} \tag{2.65}$$

Substituting the equilibrium real wage in the former equation, we obtain the equation below.

$$q^{**} = \frac{\alpha_2 + \lambda(1-\alpha_1)}{\Phi_1 p_1^* \{\alpha_2[\theta_0 + \theta_1(g_X - g_L)] + \lambda(1-\alpha_1) w_R^q\}} - \frac{\Phi_2}{\Phi_1 p_1^*} \tag{2.66}$$

As expected, whatever increases the real wage rate reduces the equilibrium ratio between the exchange rate and money wages. An increase in workers' bargaining power (α_2) and in wage indexation (α_1) reduce equilibrium q by bringing the equilibrium real wage closer to workers' targeted value $[\theta_0 + \theta_1(g_X - g_L)]$. In turn, an increase in λ brings the equilibrium real wage closer to w_R^q, thereby increasing the equilibrium ratio between nominal exchange rate to money wages. Finally, an increasing rate of unemployment increases workers' target, reducing the equilibrium q.

[36] Note that q must be positive. We can show that in a few steps. The left hand side of equation 2.65 is larger than zero as long as

$$\frac{1}{\Phi_1 p_1^*}\left(\frac{1}{w_R^{**}} - \Phi_2\right) > 0.$$

Since $\Phi_1 p_1^* > 0$, we can rewrite this condition as follows:

$$\frac{1}{w_R^{**}} - \Phi_2 > 0$$

That, in turn, implies that

$$\frac{p_2 - \Phi_2 w}{w} > 0$$

which is trivially truth since production of 2 requires that its price is larger than the direct and indirect labor costs ($p_2 > \Phi_2 w$). The reader can refer to section 2.3.4, where we define Φ_2.

2.5 Conflict inflation and distribution in the open economy

This chapter contributes to the literature of conflict inflation in the open economy by setting up a model of inflation based on the classical approach to distribution, as in its applications to the case of a small open economy. By these means, we explicitly discuss the distributive impact of the exchange rate and international prices. Once international prices directly determine part of domestic prices, they also affect distribution and conflict. Although this fact is generally acknowledged, its consequences have not been fully explored in inflation models. This section compares the different approaches to conflict inflation in the open economy with the one proposed in this chapter.

In general, open economy conflict inflation models either assume a given level of the mark-up or introduce an effect of the real exchange rate over mark-ups. In the first case, mark-up (or firm's targeted mark-up) is exogenous with respect to prices, money wages, exchange rate, and interest rate, being solely determined by the degree of monopoly. To make this mark-up compatible with the presence of international competition, these models assume the law of one price does not hold. In other words, the domestic price of a certain commodity is independent of the foreign price for the same commodity. Hence, domestic prices depend on production costs, wages, and mark-up, all determined according to the conditions of the domestic economy. International prices matter only as they explain the cost of inputs — or the price of imported consumption goods, as in Cassetti (2002) and Vera (2010). This framework is sufficient to generate a conflict between real wages and either the real exchange rate or international prices of imported commodities. Such a conflict can cause inflation in open economies, as discussed by Rowthorn (1977) and Cassetti (2002). Stirati (2001) also introduces imported inputs as a source of inflation and conflict. Although the author rejects the mark-up pricing framework existing in the other works, she assumes the profit rate is unaffected by foreign prices and the exchange rate.

Another strand of the literature considers the mark-up cannot be independent of the exchange rate and foreign prices. Two different perspectives are developed along these lines. The first considers the mark-up to be directly affected by the real exchange rate. This approach, labeled as flexible mark-up, is proposed in Blecker (1989b) and later used by Vera (2010). Thereby, Blecker (1989b) introduces a capitalists' distributive claim associated with exchange rate devaluation, because it loosens the pressure of foreign competition. Nevertheless, it raises additional problems because, in this case, the mark-up is contemporaneously determined by the degree of monopoly and by the real exchange rate. Thus, the role of each variable in the explanation of distribution is not clearly defined.

The second view departs from the Kaleckian model of inflation for the open economy. It introduces the assumption that the real exchange rate affects firms' and workers' income claims by impacting their targeted distributive variables. In other words, the real exchange rate increases firms' targeted mark-up (or reduces the firm's targeted wage share), and in some cases, it also reduces worker's targeted mark-up (or increases its targeted wage share). This approach is discussed by Lavoie (2014) and further developed by Bastian and Setterfield (2020). Once again, the ultimate determinant of the mark-up becomes blurry.

These difficulties add up to other shortcomings of mark-up pricing, especially concerning the role of the degree of monopoly as a determinant of the profit rate (criticized along this thesis).

Altogether, these shortcomings suggest that conflict inflation theory should build on an alternative explanation of distribution. Such an alternative can be found in the classical surplus approach, extended to the open economy context. In addition to avoiding the mentioned shortcomings, the distributive closure presented in this chapter allows us to consider that international prices directly determines tradable prices in open economies. Moreover, the profit rate is positively affected by the exchange rate and the international price of the tradable commodity. This property is analogous to outcomes of other models, in the form of the increase in the mark-up in the flexible mark-up approach and in the case in which the real exchange rate affects income claims.

In section 2.2, we discussed different models of inflation and conflicting claims in the open economy. Neither of these models explicitly includes the effect of international prices on the domestic price of tradable commodities. Indeed, most of them acknowledge the law of one price is disregarded. Finally, they reason in terms of mark-up pricing, and firm's targeted mark-up, whose value would be affected by the real exchange rate. In contrast, the Scandinavian model of inflation (Aukrust, 1977; Edgren et al., 1969) explicitly introduces the role of tradable prices. However, this model does not formally include the effect of distributive conflict on wage bargaining and inflation. In fact, the Scandinavian model assumed that wages change according to a rule that offsets the positive impact of international inflation (and of increases in productivity) on the profitability of tradable industries.

Other authors focused on the impact of chronic deficits in the Balance of Payments as a cause of inflation. Vernengo and Perry (2018) consider a simple structure but include a target for the real exchange rate, pursued by monetary authorities according to Balance of Payments concerns. Thus, the authors can model a money wage-exchange rate spiral, describing a typical condition of Latin American economies. However, Vernengo and Perry (2018), as well as Charles and Marie (2016), assume wages are indexed by a fixed parameter so that they do not explicitly account for wage claims in the model. For this reason, the relationship between worker's bargaining power and the conditions in the labor market is left aside. In the model presented by Charles and Marie (2016), one unstable equilibrium among multiple equilibria may lead to hyperinflation. Vera (2010) also discusses the Balance of Payments and its relation with exchange rate devaluations and conflict inflation.

This chapter introduces a target for the ratio of the nominal exchange rate to money wages owing to distributive concerns of the monetary authority. In this way, we do not explicitly cope with the Balance of Payments. However, future research can account for the Balance of Payments as an additional source of inflation.

In order to avoid the shortcomings found in the literature, this chapter seeks an alternative approach to model conflict inflation in an open economy. For this reason, we introduced a framework based on classical production prices for the open economy case. In section 2.3, we showed how the wages, profit rate, exchange rate interact according to these production prices. This setup also laid the foundation for deriving the expressions for the rate of inflation and obtaining the model's equilibrium — according to the relation between prices and exchange rate, on the one hand, with profit rate and real wage rate, on the other.

In contrast with the Kaleckian approaches, here, capitalists cannot target a desired income share. In fact, they set prices constrained by competition, and thereby the profit rate is regulated by the interaction between money wages, nominal exchange rate, and international prices. The real outcome of distribution is known only after the inflationary process. Moreover, we explicitly account for tradable prices in a conflict inflation model, contrasting with the literature reviewed. A consequence emerging from this feature is the raise of profit rate after an exchange rate devaluation. Competition generates a tendency for a rise in prices of non-tradable commodities, allowing for the adjustment towards a higher profit rate in the tradable commodity production. That consists of an additional cause of inflation related to an income claim of capitalists of non-tradable sectors driven by competition. Thereby, we account for an inflationary pressure neglected in the literature. The model also account for other causes of inflation related to open economy concerns. First, the direct impact of tradable prices. As argued before, this channel is often disregarded. Second, the channel of imported inputs, whose costs transmitted to final prices and interact with distribution.

Several results of our analysis are in line with expected outcomes of conflict inflation models. Stronger bargaining power of workers, due to the fall in unemployment or larger institutional power (*i.e.*, a higher θ_0), is associated with higher real wages and a higher rate of inflation. It is also associated with a lower value of q, and a lower real exchange rate. Indeed, Cherkasky and Abeles (2019) show that the weakening of worker's bargaining power, in the form of weaker trade unions and the retreat of labor market institutions, reduce the pass-through after exchange rate devaluations. Hence, the authors argue that the lower inflationary impact of an exchange rate devaluation is caused by the lower wage resistance given the weaker institutional support of workers. In our model, this can be shown by imposing a lower value of θ_0, which leads to a lower rate of inflation, lower real wage, and higher real exchange rate.

Finally, we contend this chapter brings new insights into the distributive closures within the classical surplus approach. Developments in the surplus approach rejected any mechanistic approach to the theory of distribution and emphasized the role of institutions and political factors (Pivetti, 1991; Sraffa, 1960; Stirati, 1994). Insights from this approach were applied in the discussion of inflation by Pivetti (1991); Serrano (2010); Stirati (2001). However, the price-taker open economy analytical framework had not been employed in an analysis of inflation till now.

Within the Classical surplus approach, the monetary theory of distribution stressed the role of nominal variables in determining income distribution. Pivetti, following a hint of Sraffa, takes the nominal interest rate as the exogenous variable in the system of prices equations determining relative prices and distribution. However, the actual outcome (*i.e.*, real profit rate and real wages) of distribution can only be known after wage bargaining and the inflationary process take place. As argued by Pivetti (1991, p. 52), " given a policy-determined nominal interest rate, competition among firms within each industry should tend to cause the rate of profit to move in sympathy with the real rate of interest, rather than with the nominal one, because it is the former which constitutes the actual price for the use of capital in production or its opportunity cost". In other words, since the price of labor and capital goods has changed at the end of each period, the relevant value of the profit rate must be evaluated with respect to these new prices (and new production costs) rather than the initial ones.

Based on this point, Serrano (1993) emphasized that even though the monetary authority can peg the nominal interest rate of the economy, it cannot fully determine distribution since workers can react to increases in the nominal interest rate preserving their income share. Thus, the real interest rate remains to be determined by the nominal interest rate and wage bargaining (in a closed economy).[37]

The results presented in this chapter reveal an analogy with the monetary theory of distribution. Nevertheless, rather than the nominal interest rate, distribution is regulated by the nominal exchange rate, international prices, and money wage rate. In line with Post-Keynesian developments, we consider the nominal exchange rate to be strongly influenced by monetary policy within certain constraints. Our price equations explicitly show the exchange rate is a relevant distributive variable in this small open economy context. Hence, there is a relation between the nominal exchange rate and the ratio between prices and money wages. We try to show, however, that as wages can react to an exchange rate depreciation, the outcome depends on the reaction of wage bargaining and the inflationary process. As a consequence, the real exchange rate, known at the end of the period, is relevant to the outcome in distribution, rather than the nominal exchange rate. From this perspective, the chapter contributes to this analysis of distribution in the open economy context, considering the distributive variables determining income distribution, wage bargaining, and the distributive conflict.

[37] When discussing the monetary theory of distribution, Serrano (1993, p. 123) argues that "[Pivetti] has convincingly shown that (again, in a fiat money context) the nominal rate of interest is determined independently from the 'real side' of the economy. This complete 'autonomy' of the nominal rate of interest means that this variable might not always be compatible with the bargaining position of the workers or the possibilities of the technology of the economy". Garegnani had anticipated the same point: "Indeed, it seems reasonable to suppose that, as a result of competition in product markets, the average rate of profit and the average rate of interest on long-term loans will tend, over a sufficiently long period of time, to move in step with one another. If, then, the rate of interest depends on the policy of the monetary authorities, both the long-term movement of the average rate of profit and, through the relation just mentioned, that of real wages are explained by that policy. This does not entail maintaining afresh that the wage bargain has no power to change real wages: the policy of the monetary authorities is not conducted in a vacuum and the movement of prices and of the money wages determined in the wage bargain will be amongst the most important considerations in the formulation of that policy" (Garegnani, 1979, p. 81).

2.6 Final Remarks

We build on open economy price equations to develop a conflict inflation model following a Classical-Keynesian perspective. The extension of price equations to the open economy defined the relation among money wages, exchange rate, international prices, and the profit rate. Based on this setup, we further derived expressions for the inflation rate, the real wage rate, and its relation with the real exchange rate. An increase in international prices or an exchange rate devaluation raises production costs through more expensive inputs. That pushes prices up, possibly leading to a persistent inflation as workers respond to protect their purchasing power. Since the model includes tradable prices, these shocks also have a direct impact on prices and distribution. All else being equal, the tradable sector's profit rate increases after an exchange rate devaluation. Competition pushes prices of non-tradable commodities due to the tendency of convergence of profit rates. That describes an additional cause of inflation included in the model.

Finally, the chapter brings new insights into the distributive closures within the Classical-Keynesian approach. Contributions in this approach highlighted the interest rate as an independent monetary variable that regulates income distribution. However, the real interest rate is the meaningful variable, being known after inflation occurs. Hence, the social conflict causing inflation also shapes distribution (Pivetti, 1991; Serrano, 1993; Stirati, 2001). Our model provides analogous results for the open economy setup. We conclude that the nominal exchange rate becomes a central variable for distribution in small open economies. However, its ultimate impact on distribution is conditional on the reactions of workers through bargaining and inflation.

Appendix

A Mathematical Appendix

Determination of the level of employment

This appendix presents omitted mathematical passages to obtain the level of employment, as in equation 2.4.

We depart from the expression from the level of employment, presented in equation 2.38 and rewritten below.

$$L = l_1 Q_1 + l_2 Q_2$$

By substituting 2.43 and 2.40 in the expression for the level of employment and rearranging, we obtain the following equation:

$$L = l_1 \frac{X}{\left[1 - a_1 - a_2\left(\frac{w_R l_1}{1 - w_R l_2}\right)\right]} + l_2\left(\frac{w_R l_1}{1 - w_R l_2}\right)\frac{X}{\left[1 - a_1 - a_2\left(\frac{w_R l_1}{1 - w_R l_2}\right)\right]} \quad [2.67]$$

Rearranging gives us the following expression

$$L = \left[l_1 + l_2\left(\frac{w_R l_1}{1 - w_R l_2}\right)\right]\frac{X}{\left[1 - a_1 - a_2\left(\frac{w_R l_1}{1 - w_R l_2}\right)\right]} \quad [2.68]$$

We can rewrite as follows in equation 2.69. In this case, we are able to distinguish the impact of exports and of real wages on employment.

$$L = \left\{\frac{\left[l_1 + l_2\left(\frac{w_R l_1}{1 - w_R l_2}\right)\right]}{\left[1 - a_1 - a_2\left(\frac{w_R l_1}{1 - w_R l_2}\right)\right]}\right\} X \quad [2.69]$$

Thus,

$$L = \left\{\frac{\frac{l_1(1 - w_R l_2) + l_1 l_2 w_R}{(1 - w_R l_2)}}{\frac{1 - w_R l_2 - a_1 + a_1 w_R l_2 - a_2 w_R l_1}{(1 - w_R l_2)}}\right\} X = \left\{\frac{l_1}{1 - a_1 + w_R(a_1 l_2 - a_2 l_1 - l_2)}\right\} X \quad [2.70]$$

Finally, L can be written as

$$L = \left\{ \frac{l_1}{1 - a_1 + w_R((-l_2)(1 - a_1) - a_2 l_1)} \right\} X \quad [2.71]$$

This is the expression presented in the chapter as equation 2.44. The term within braces can be understood as the employment multiplier compatible with the input-output structure of the model and the assumptions — in particular the assumption that workers spend all their income in commodity 2.

As expected, the multiplier is positive. We can show that this term is positive by showing that the denominator of this fraction is positive. Note that all the technical coefficients (a_i, l_i) are positive.

Let us assume, *ab absurdo*, that the denominator of the last equation is equal to zero. Viability of this economy requires that $a_1 < 1$.[38] Then, using the fact that $w_R = w/p_2$, we would have:

$$1 - a_1 + \frac{w}{p_2}((-l_2)(1 - a_1) - a_2 l_1) = 0$$

In this case,

$$w = p_2 \left[\frac{1 - a_1}{l_2(1 - a_1) + a_2 l_1} \right]$$

If we divide both sides per p_1, we obtain:

$$\frac{w}{p_1} = \frac{p_2}{p_1} \left[\frac{1 - a_1}{l_2(1 - a_1) + a_2 l_1} \right]$$

By setting $p_1 = 1$,

$$\frac{w}{p_2} = \frac{1 - a_1}{l_2(1 - a_1) + a_2 l_1} \quad [2.72]$$

However, this value for the real wage is larger than the maximum value for the real wage admissible in this economy. Indeed, this expression coincides with the maximum real wage in terms of 2 that would be observed if there were no imported inputs. As this value for the real wage is not possible in the open economy case, we know that w_R is smaller than the one expressed above, what implies that the denominator of the fraction studied is larger than zero.

The maximum real wage compatible with the system of price equations can be obtained by setting $r = 0$ in the system constituted by equations 2.3 and 2.4. Setting a

[38] See, for instance, (Kurz and Salvadori, 1997, p. 64-65).

zero profit rate in equation 2.3 and rearranging gives us:

$$w = \frac{p_1 - a_1 p_1 - a_m p_m}{l_1} \qquad [2.73]$$

Now, we can find an expression for the price of commodity 2 compatible with this value for the maximum wage rate obtain in production of commodity 1. By substituting the last result in the price equation for 2 after setting also $r = 0$, we obtain:

$$p_2 = a_2 p_1 + a_\mu p_\mu + \left(\frac{p_1 - a_1 p_1 - a_m p_m}{l_1}\right) \qquad [2.74]$$

Rearranging, we get:

$$p_2 = \frac{l_1(a_2 p_1 + a_\mu p_\mu) + l_2[p_1(1 - a_1) - a_m p_m]}{l_1} \qquad [2.75]$$

Dividing the right-hand side of equation 2.73 per the right-hand side of equation 2.75 gives us an expression for the maximum real wage rate in terms of commodity 2.

$$\frac{w}{p_2} = \frac{p_1 - a_1 p_1 - a_m p_m}{l_1(a_2 p_1 + a_\mu p_\mu) + l_2[p_1(1 - a_1) - a_m p_m]} \qquad [2.76]$$

As before, we set $p_1 = 1$, obtaining an expression comparable to the real wage obtain previously in equation 2.72. After this procedure, the price of each commodity correspond to the relative price with respect to commodity one.

$$\frac{w}{p_2} = \frac{1 - a_1 - a_m p_m}{l_1(a_2 + a_\mu p_\mu) + l_2[1 - a_1 - a_m p_m]} \qquad [2.77]$$

It is easy to check that this value for the maximum real wage is smaller than the one established in equation 2.72, whenever $(1 - a_1)a_\mu p_\mu + a_2 a_m p_m > 0$. This condition is verified when at least in one sector production requires imported inputs. Indeed, this result can be immediately interpreted from an economic viewpoint, since the maximum real wage must be smaller in the second case, because production requires a larger quantity of inputs.

B Real exchange rate

The purpose of this note is to show the relation between the real exchange rate and the distributive variable q defined in equation 2.23. The discussion related to this appendix is presented in the subsection 2.3.5. The most common definition of real exchange rate corresponds to the nominal exchange rate adjusted by the price levels. Let us consider here our price-taker open economy and another economy labeled as the Rest of the World, whose variables will be signed with an $*$. For simplicity, we consider commodities 1 and 2 to be the only final goods in those economies. However, the same argument could be developed in a more complex set up. Since commodity 1 is tradable, its price must be equal across countries. Therefore, the price index in each country consists in a weighed average of the prices of these commodities. This means we can write the expression for the real exchange rate as follows.

$$e_R = e\left[\frac{\gamma p_1^* + (1-\gamma)p_2^*}{\delta e p_1^* + (1-\delta)p_2}\right] \tag{2.78}$$

As demonstrated in subsection 2.3.4, in particular in equation 2.19, the price of commodity 2 can be decomposed into the domestic price of 1 and labor. The share of each part, however, depends on the technical coefficients and on relative prices of the tradable commodity and imported inputs. Even though these relative prices are equal in both economies, by assumption, we do not impose that technical coefficients must be the same. Consequently, these shares differ across these two economies. In the case of domestic economy, we have the value expressed in equation 2.19 rewritten below.

$$p_2 = \Phi_1 e p_1^* + \Phi_2 w \tag{2.79}$$

In the case of the Rest of the World, assume these weights are given by ζ_1 and ζ_2. Thus, we can write:

$$p_2^* = \zeta_1 p_1^* + \zeta_2 w^* \tag{2.80}$$

Therefore, the real exchange rate can be expressed as:

$$e_R = e\left\{\frac{[\gamma + (1-\gamma)\zeta_1]p_1^* + (1-\gamma)\zeta_2 w^*}{[\delta + (1-\delta)\Phi_1]e p_1^* + (1-\delta)\Phi_2 w}\right\} \tag{2.81}$$

We can rewrite the last equation as follows below, by collapsing the coefficients into a simpler notation.

$$e_R = e\left(\frac{\gamma_1^{'} p_1^* + \gamma_2^{'} w^*}{\delta_1^{'} e p_1^* + \delta_2^{'} w}\right) \quad [2.82]$$

Finally, the last equation can be rewritten as follows below. This shows that the real exchange rate varies inversely with the ratio $\frac{w}{e}$, so that it varies proportionally with the ratio $\frac{e}{w}$, which corresponds to our definition for q.

$$e_R = \left(\frac{\gamma_1^{'} p_1^* + \gamma_2^{'} w^*}{\delta_1^{'} p_1^* + \delta_2^{'} \frac{w}{e}}\right) \quad [2.83]$$

Chapter 3

International inflation and trade linkages in Brazil under inflation targeting

3.1 Introduction

Inflation theory has focused mainly on the role of domestic variables, addressing the role of international variables only to a lesser extent. Although international prices imposed strong pressures on inflationary processes historically, they are often overlooked during periods of price stability. Recently, a growing literature shows that inflation is a global phenomenon, suggestion inflation models should add focus for international prices, trade, and foreign competition.

International price shocks are often assumed to be transmitted to domestic prices exclusively through imports. Borio and Filardo (2007) argue that this belief results from the dominance of a "country-centric" perspective. The authors argue that country-centric inflation models implicitly assume that domestic produced goods and foreign goods are very imperfect substitutes – otherwise one would interfere directly in the price formation of the other. In addition, those models often assume (whether explicitly or not) very limited substitutability between domestic and foreign labor inputs. Hence, international measures of economic slack or international costs of labor are usually neglected in empirical analysis for a specific country. Borio and Filardo (2007) argue that the larger stability of prices and inflation in the 1990s and 2000s was spread across countries. In this view, the global nature of the decline of inflation requires a global explanation.

The larger integration of international markets and the constitution of global value chains makes domestic inflation more sensitive to international developments (Bobeica and Jarocinski, 2019; Ciccarelli and Mojon, 2010; Mumtaz and Surico, 2012). International competition and foreign prices also explain a great share of the inflation across countries (Auer et al., 2017, 2019; Bugamelli et al., 2015). Still, Auer et al. (2019) shows that cross-country trade input-output linkages is the most important factor in explaining producer inflation synchronization across countries. Although many of these results refer to advanced economies, the role of international variables tend to be even more prominent in emerging economies. In fact, exchange rate shocks and commodity prices have usually been considered the main causes of inflation in developing countries.

Studies focusing on the Brazilian economy have pointed the exchange rate and commodity prices as the main determinants of domestic inflation (Bastos et al., 2015; Braga and Summa, 2016; Modenesi and Araújo, 2013; Nassif et al., 2020). The dominance of international factors constrains the operation of the inflation targeting regime. Theoretically, inflation targeting seeks to control inflation through the manipulation of aggregate demand by changing the interest rate. The exchange rate is expected to play an auxiliary role in open economy inflation targeting regimes by directly affecting import prices and reducing the demand for exports (Svensson, 2000). Nevertheless, the exchange rate has been the dominant transmission mechanism of monetary policy shocks to domestic prices in Brazil (Nassif et al., 2020). Exchange rate appreciation following monetary policy shocks directly impact the prices of tradable goods and imports.

However, a cost-channel related to international input-output linkages has not been analyzed in the literature. Although the importance of exchange rate and commodity prices is established for the Brazilian case, the role of imported costs has not been properly addressed. For this reason, this paper introduces an index of foreign cost shocks, following Auer et al. (2017). We compute an average of other countries' producer prices weighted by the yearly share of each country in Brazilian imports of capital and intermediate goods.

The chapter investigates the domestic and international causes of Brazilian inflation, focusing on the impact of other countries' inflation on Brazilian inflation. We estimate a Structural Vector Autoregression model to test the impact of international cost-shocks on Brazilian inflation. We therefore included a variable that combines the Producer Price Index (PPI) of Brazil's trade partners, in addition to the usual variables that identify real and monetary shocks. Foreign PPI explains a relevant share of inflation in Brazil during the period 1999-2020. We conclude that this variable provides an additional channel through which external shocks affect domestic inflation in Brazil, contributing to the literature on the matter. Such result raises additional concerns on the effectiveness of monetary policy as the single instrument of the inflation targeting regime.

3.2 Inflation and International Shocks

3.2.1 The globalization of inflation

Empirical evidence shows the growing importance of the international component in the explanation of inflation rates across countries (Bobeica and Jarocinski, 2019; Borio and Filardo, 2007; Ciccarelli and Mojon, 2010) . Meanwhile, conventional empirical specifications of the Phillips curve centered on measures of the domestic output slack have been loosing explanatory power in the last decades (Borio and Filardo, 2007). These "country-centric" approaches have focused mainly on domestic slack, overlooking international variables (Auer et al., 2017; Borio and Filardo, 2007). A country-centric perspective implicitly assumes that: i) production supply chains are fully domestic; ii) foreign and domestic goods are highly imperfect substitutes and priced in domestic currency; iii) there is limited mobility of labor (Auer et al., 2017).

Growing international integration in recent times has inspired criticism against the dominance of country-centric approaches to inflation for focusing mainly on domestic variables (Borio and Filardo, 2007). On the contrary, international factors are shown to account for much of national inflation dynamics across countries (Bobeica and Jarocinski, 2019). Empirical evidence shows that international prices, cross-border input-output linkages, and measures of trade integration play a relevant role in explaining inflation in advanced and developing economies. Indeed, the decline in inflation in advanced economies seems to have benefited from the competition of imports from low-wage countries (Bugamelli et al., 2015). Studies also report that the increasing economic integration intensified the importance of foreign inflation in explaining domestic inflation and the increased synchronicity of inflation rates across countries (Bobeica and Jarocinski, 2019; Borio and Filardo, 2007; Ciccarelli and Mojon, 2010). A detailed analysis according to product category confirms these results, showing that international factors have gained importance for most of the product categories (Karagedikli et al., 2010). Furthermore, global inflation rates act as an attractor for national inflation rates (Ciccarelli and Mojon, 2010). These results suggest empirical studies should attribute greater importance to international variables in order to explain domestic inflation in both advanced and developing economies. Therefore, analysis of inflation should account for the high substitutability of tradable goods, pressures of international competition, mobility of labor, and the great importance of cross-border input-output linkages. Acknowledging these effects also implies focusing on the impact of international prices of goods and inputs, foreign wage rates, and exchange rates (Bugamelli et al., 2015).

Supply chains are global and connect a wide range of countries. Greater intergration in Global Value Chains cause greater contestability at each stage of the production process, meaning that firms can avoid the price effect of supply and demand shocks from one country as they alter their sourcing decisions towards another country. This process dampens the impact of inflationary shocks at an international scale. Auer et al. (2017) show that the more intense integration in Global Value Chains, the more reduced the sensitiveness of final prices to domestic slack across different countries.

International competition is thus manifested not only through higher interrelations in supply chains but also by the greater contestability at each stage of production. The importance of supply chains is reinforced by the finding that trade in intermediate goods and services is the main transmission mechanism of global shocks to domestic prices (Auer et al., 2017). Moreover, Auer et al. (2019) show the relevance of international input-output linkages in explaining the high synchronization of inflation across countries. These results stand out for reclaiming the role of the cost channel as an important transmission mechanism of international shocks to domestic inflation.

The exchange rate also plays a crucial role in the relation between international shocks and domestic prices. Exchange rate pass through into import prices is high across different countries (except for the US). Gopinath et al. (2020) show that the majority of trade is invoiced in a few currencies, with an outstanding role of the US dollar. Firms set trade prices in these currencies, and pass-through exchange rate shocks to final prices. Devaluations with respect to these currencies therefore imply a proportional increase in the domestic price of imports. This regularity supports the view that the dollar is the dominant currency in the international payments system, profiting from an asymmetric position. According to this view, (mostly dollar) (Gopinath et al., 2020). In contrast, from the domestic viewpoint, exports tend to be less sensitive to exchange rate movements. In this case, an exchange rate depreciation does not lower export prices, as they are invoiced in foreign currency, but increases the mark-up of exporting firms (Gopinath, 2015). These conclusions confirm the asymmetric position of the US due to dollar's invoicing currency status in world trade. While exchange rate devaluations in the US strongly affect inflation in other countries, inflation in the US is unaffected by others' exchange rate movements (Gopinath, 2015). Furthermore, evidence shows that these features hold for both advanced and developing economies

(Giuliano and Luttini, 2020; Gopinath et al., 2020). This conclusion suggests the case of the price-taker open economy (advanced in the second chapter of this thesis) may not be restricted to peripheral or small economies, but holds more generally, at least concerning some commodities.

3.2.2 Inflation targeting and international shocks in Brazil

Brazil adopted the inflation targeting policy regime in 1999 after five years of stabilization policies based on exchange rate targeting regime, which ended on a major currency crisis (Barbosa-Filho, 2008). The introduction of the inflation targeting regime shifted the policy instrument in the classical "trilemma" of open economies.[1] In other words, Brazil chose to have an independent monetary policy, free capital flows and a floating exchange rate (Barbosa-Filho, 2008). By pegging the short-term interest rate, monetary policy became the main macroeconomic policy. The interest rate, in turn, became the main instrument of macroeconomic policy (Nassif et al., 2020).[2]

The Central Bank of Brazil sets the basic interest rate aiming to make inflation converge towards the inflation target established by the National Monetary Council. Brazilian inflation targeting regime works according to an annual target for full (rather than core) inflation to be achieved within each calendar year. The target has a tolerance range, which varied in the last two decades. In this period, inflation rate was outside the tolerance range in six years: 2001, 2002, 2003, 2015, 2017, and 2021. With the exception of 2017, in which inflation rate was below the target, in all the other cases the inflation rate exceeded the inflation target, owing to substantial shocks in the exchange rate or in commodity prices.[3]

The success of the inflation target regime has frequently relied on currency appreciation, especially in years of international price shocks (Barbosa-Filho, 2008; Nassif et al., 2020). Despite keeping inflation within a foreseeable range, inflation targeting has been associated with a poor performance in terms of growth, and with the persistence of high real interest rates (Modenesi and Araújo, 2013; Nassif et al., 2020).

[1] See Mundell (1960).

[2] This policy regime is thus in line with the guidelines of the New Macroeconomic Consensus. In this view, by properly anchoring inflation expectations, leading the inflation to its target would imply also closing the output gap in the so-called *divine coincidence* (Blanchard and Galí, 2007). A brief discussion on the New Keynesian Phillips Curve can be found in the first chapter of this thesis. In this framework, a flexible exchange rate would play an auxiliary role.

[3] Although the interest rate is the relevant policy instrument in the inflation targeting regime, in open economies, a complementary role is played by the nominal exchange rate through its direct impact on prices and foreign demand (Svensson, 2000).

Estimates highlighted the role of the exchange rate and commodity prices as the main explanations of inflation in Brazil. Braga and Bastos (2010) estimate an Autoregressive Distributed Lags Model with data from 1999 to 2008 to analyze the causes of inflation in Brazil. While the international price of basic commodities and the exchange rate were the main causes of inflation, excess demand and money wages were not significant in this estimate. Other studies disaggregated the components of inflation, searching for industry-specific explanations of price changes (Bastos et al., 2015; Braga, 2013; Braga and Summa, 2016; Martinez and Cerqueira, 2013). These studies verify if aggregated results are also observed in the industry level. Besides, they capture the relation between inflation and the change in relative prices. The relative importance of each sector on Brazilian inflation has varied since 1999. In times of international price shocks, foodstuff and other tradable dominate the price index. In a recent period of labor market tightening, inflation was concentrated in services rather than in industrial goods (Santos et al., 2018). Disaggregating inflation among durable goods, semi-durable goods non-durable goods and services, Braga (2013) shows that the main cause of inflation was imported inflation – a measure that combines the index for international price of basic commodities and the Brazilian exchange rate. The author also found a structural break in the series of prices monitored by the government. This series achieved greater stability in 2006, confirming the success of regulatory changes introduced in this period in order to reduce the impact of public services in total inflation (Braga, 2013; Martinez and Cerqueira, 2013).

Braga and Summa (2016) disaggregated inflation in four components: prices monitored by government, foodstuff, industrialized goods and services. In their analysis, based on data for the period 1999-2012, the exchange rate and international prices affected all four components of inflation. Another result obtained is that inflation of the services sector presented a great degree of inertia.[4] Finally, Bastos et al. (2015) adopted a model of auto regressive distributed lags to investigate the behavior of inflation over seventeen distinct industries (from extractive industry and manufacturing), using data for the period 1996-2011. Results reiterated the importance of the exchange rate and of international prices of basic commodities among the determinants of the inflation in industrial goods. The industries in which imported inflation presented a higher impact were those with greater interaction with

[4] The role of past inflation in explaining current inflation has been highlighted in different studies. In general, the autoregressive component of inflation has been found to be significant and strong. Nevertheless, inertia is not large enough to justify an accelerationist interpretation of the Phillips curve (Summa, 2011).

international markets and with larger diffusion of imported inputs and final goods (Bastos et al., 2015).

3.3 Data

Our dataset comprises the variables usually included in time series analysis of inflation and monetary policy (Miranda-Agrippino and Ricco, 2021) Consumer Price Index, Interest rate, GDP, Exchange Rate, and Commodity Prices. The novelty of this paper is to introduce an index of imported cost-shocks at the intermediate goods level. That is done with the inclusion of a Foreign PPI, following Auer and Mehrotra (2014), and Auer et al. (2019). These authors employed this index to analyze price co-movements across countries, showing that input-output linkages are fundamental to explain the synchronization of inflation rates across advanced economies. We introduce the Foreign PPI in a time series analysis of Brazilian inflation. Imported cost-shocks may generate an additional source of inflation in open economies, in addition to commodity prices and exchange rates. Next section provides further details about the construction of the measure of the Foreign PPI for Brazil.

The measure of CPI is the National Price Index to the Broad Consumer (IPCA), released monthly by the Brazilian National Bureau of Geography and Statistics (IBGE). The index measures the inflation of a bundle of goods and services traded in retail. The index's bundle corresponds to the household consumption of 90% of the population in the areas covered by the National System of Consumer Price Indexes. It is noteworthy that the inflation target pursued by the Central Bank is set in terms of the IPCA, which is therefore the most relevant price index for monetary policy.

Recent studies of inflation and monetary policy include an index of industrial production as a measure of output slack, identifying demand shocks (Miranda-Agrippino and Ricco, 2021; Ramey, 2016). However, the growing importance of services suggest that industrial production may not completely capture demand shocks. Services have dominated inflation in Brazil in the early 2010s (Santos et al., 2018). Therefore, we include real GDP to account for domestic shocks of supply and demand. The monthly series of the real GDP is generated by the Central Bank of Brazil, through an interpolation of the Quarterly GDP series released by the Brazilian National Bureau of Geography and Statistics (IBGE). The interpolation into a monthly basis is based on additional data on industrial production, electric energy consumption, primary goods exports, and price indexes. As a robustness check, we replace real GDP with an index of industrial production in the VAR estimate. We find similar results, as reported in section 3.6.1.

As for the interest rate, we choose the one year base nominal rate as our policy variable as in Gertler and Karadi (2015). The variable for the interest rate is the nominal policy rate set by the Central Bank of Brazil, on a yearly basis. Figure 3.1 shows that the interest rate series was at a peak in the first years of the inflation targeting regime, as a response to adverse external shocks. In the following years, the interest rate decreased progressively, in spite of the occasional policy shocks in response to inflation.

The measure of the exchange rate is the monthly average of the nominal dollar-real exchange rate. The exchange rate is expressed in dollars per real ($US\$/R\$$). An increase in the exchange rate variable thus implies a depreciation of the Brazilian currency with respect to the U.S. dollar. The choice of the exchange rate variable is consistent with the central role of the U.S. currency in price setting globally (Casas et al., 2017; Gopinath, 2015). Gopinath et al. (2020, p. 678) argue that the "vast majority of trade is invoiced in a small number of currencies, with the US dollar playing a dominant role". Therefore, the dollar exchange rate dominates the bilateral exchange rate in price pass-through estimates. The US dollar is also a key predictor of trade volume and inflation in the rest-of-world (Casas et al., 2017; Gopinath et al., 2020).

The preference for the nominal dollar-real exchange rate over measures of the effective exchange rate is also due to the correlation of the effective exchange rate with the Foreign PPI. Both variables consist of an average weighted according to the share of countries in Brazilian trade. Hence we include the nominal dollar-real exchange rate, to capture the pure exchange rate effect in the baseline model.

Consumer Price Index, GDP, Commodity Price index and PPI are included in logs. Interest rate is expressed in the nominal units for 12 month period. All the series are introduced in a monthly basis from January of 1999 until December of 2020. The sample, thus, includes 264 observations for six variables. Data sources are summarized in table 3.1.

TABLE 3.1: Summary of Data

Variable	Description	Source
CPI	Consumer Price Index (IPCA)	IBGE
Interest Rate	Base Interest Rate in Brazilian Central Bank accumulated in 12 months	BCB
Real GDP	Real GDP 12 months	IBGE
Exchange Rate	Nominal Effective Exchange Rate	BCB
Foreign PPI	Producer Price Index of Brazilian Imports	Own Elaboration. Data from MDIC, EuroStat, OECDStat and National Sources.**
Commodity Prices	Commodity Price Index	IMF

* IBGE stands for the Brazilian National Bureau of Geography and Statistics. BCB stands for the Central Bank of Brazil. MDIC is the Ministry for Development, Industry and International Trade. IMF, International Monetary Fund.
** National Sources are detailed in the Appendix.

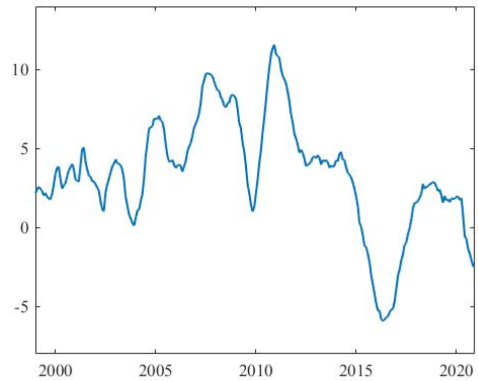
3.3.1 Stationarity Analysis

We analyzed the stationarity of the series by running Augmented Dickey Fuller and Phillips Perron tests. We conclude that CPI, GDP, Exchange rate, Commodity prices and Foreign PPI have a unit root. The first-difference of all those series is stationary. The level of Interest Rate is stationary. Test statistics and p-values for level and first-difference unit root tests are reported in the appendix A.

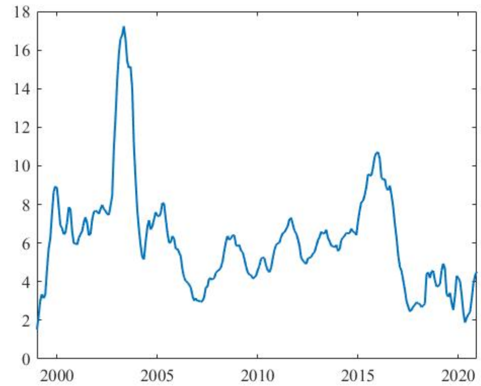
Johansen trace test indicates the existence of two cointegration relationships among the model variables at the 5% level.[5] The presence of cointegration relations suggest the preference for including cointegration vectors in a Vector Error Correction models with variables in first difference. Nevertheless, an alternative approach lies in the estimate of VARs in levels without imposing restrictions related to the cointegration relations. Levels VARs are often chosen in the literature (Miranda-Agrippino and Ricco, 2021) since they are robust to cointegration and provide consistent impulse-response functions in the short run.

[5] Johansen trace test is reported in Appendix B.

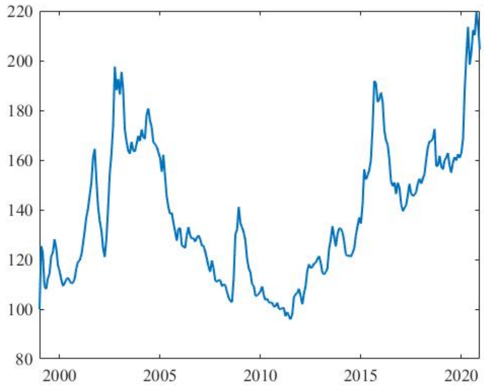
(A) *GDP*



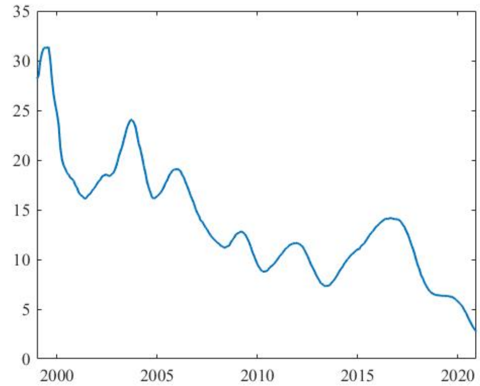
(B) *CPI*



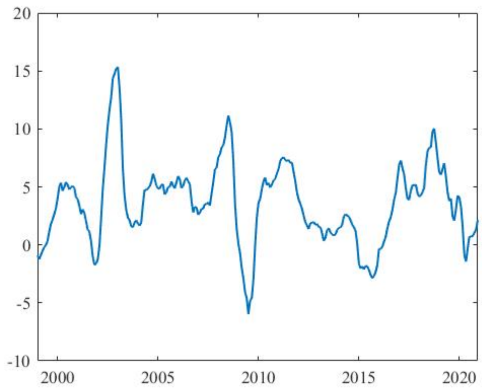
(C) *Echange Rate*



(D) *Interest Rate*



(E) *Foreign PPI*



(F) *Commodity Prices*

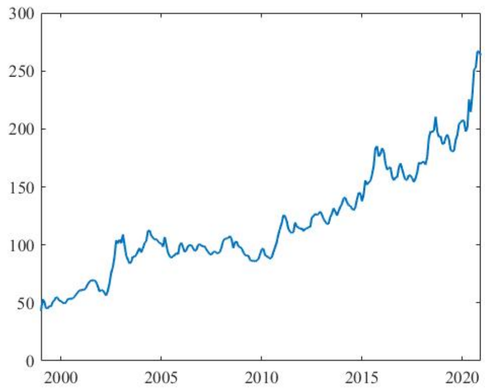


FIGURE 3.1: *Summary of Data, 1999-2020.*

Note: GDP, CPI and Foreign PPI in percentage change over 12 months. Exchange Rate, Interest Rate and Commodity Prices in levels.

3.4 Methodology

3.4.1 Foreign PPI

We build a Foreign Producers Price Index for Brazil, inspired by Auer and Mehrotra (2014) and Auer et al. (2019). The authors derive country-level indexes of imported producer prices to capture cost-shocks at sectorial and aggregate levels.

The ultimate object of interest is the country-level rather than sector-level inflation. Thus, we aggregate sectoral PPI series and cost shocks using sectoral output weights.

Previous studies have examined the role of input linkages in inflation synchronization (Auer et al., 2017; Auer and Saure, 2013). Other studies have used data on global input linkages, domestic prices and nominal exchange rates to obtain measures of real exchange rates, as Bems and Johnson (2017) and Patel et al. (2019).

$$PPI_t = \sum_{c \in C} \omega_{c,t} \left(\frac{PPI_{c,t}}{\varepsilon_{c,t}} \right) \quad [3.1]$$

Equation 3.1 shows how we computed the Foreign PPI. The variable is a weighted average of the producer price indexes of Brazilian trade partners. The ratio between each countries' producer price index ($PPI_{c,t}$) and its exchange rate with respect to the dollar ($\varepsilon_{c,t}$) gives us each countries' producer inflation in dollar terms. $\varepsilon_{c,t}$ is the average for period t of the rate defined as the unit of the currency of country c required to buy one dollar. The inclusion of the exchange rate is an refinement on the measure proposed by Auer and Mehrotra (2014) and Auer et al. (2019). These authors studied a sample mainly formed by countries with great stability of prices and exchange rates. While omitting the exchange rate is unlikely to be a problem in studies focusing on advanced economies, that is not the case for emerging market economies. A few Brazilian trade partners presented very high inflation rates in the period, so that they dominate the index if we omit the exchange rate. These high inflation rates often emerge from high exchange rate devaluations. In that case, the change in prices as measured in foreign currency is the net outcome of the two contradictory effects. This net effect, captured in our index, is the measure coherent with the economic transmission mechanism since the final impact of a country's inflation on other economies depends on the combined effect of domestic inflation and the exchange rate.[6]

[6] In other words, the impact of inflation in country A on inflation in country B also depends on the changes in

The weights ($\omega_{c,t}$) are given by the annual share of each country (c) in Brazilian imports of Intermediate and Capital goods. Brazilian trade data is processed by the Special Secretary of Trade and International Affairs (Secint), being classified into four groups: capital goods, intermediate goods, consumption goods, fuels and lubricants. A small portion of traded goods fall in the non-specified residual classification.

The countries included in the sample for computing Brazilian Foreign PPI were responsible for more than 80% of Brazilian imports of Intermediate and Capital goods during the period 1999-2020. Table 3.2 presents the average share of each country included in the index in Brazilian imports of intermediate and Capital goods in the whole period. The table shows that these imports are distributed among advanced and developing economies.

TABLE 3.2: Average share in Brazialian Imports of Intermediate and Capital goods, per country, 1999-2020.

United States	19.33%	Russia	1.58%	Turkey	0.30%
China	13.00%	India	1.37%	Norway	0.30%
Germany	8.51%	Sweden	1.28%	Czech Republic	0.29%
Argentina	7.32%	Belgium	1.09%	Ireland	0.27%
Japan	4.70%	Thailand	1.04%	Portugal	0.24%
Korea	3.76%	Netherlands	0.89%	Hungary	0.19%
Italy	3.55%	Paraguay	0.62%	Slovakia	0.07%
France	3.42%	Finland	0.60%	Luxembourg	0.06%
Spain	1.95%	South Africa	0.44%	Greece	0.05%
Mexico	1.88%	Denmark	0.37%	Slovenia	0.04%
United Kingdom	1.75%	Poland	0.32%	Estonia	0.02%

The countries add up to 80.6% of Brazilian imports of Intermediate and Capital goods in the period 1999-2020.

The evolution of the share of the main countries since 1999 can be seen in Figure 3.2. The figure reveals the trends of Brazilian trade found in the last two decades as the rise of Chinese share and the relative loss of importance of the United States. For our purposes, this implies that inflation in China is increasingly more influential to explain inflation in Brazil (as may be the case for many countries).

The implicit hypothesis that foreign producer price shocks are passed through to domestic prices is compatible with marginal cost pricing and constant markups over average costs (Auer et al., 2019). This hypothesis is also compatible with the theoretical framework presented in the second chapter of this thesis.

the exchange rate between the currencies of A and B.

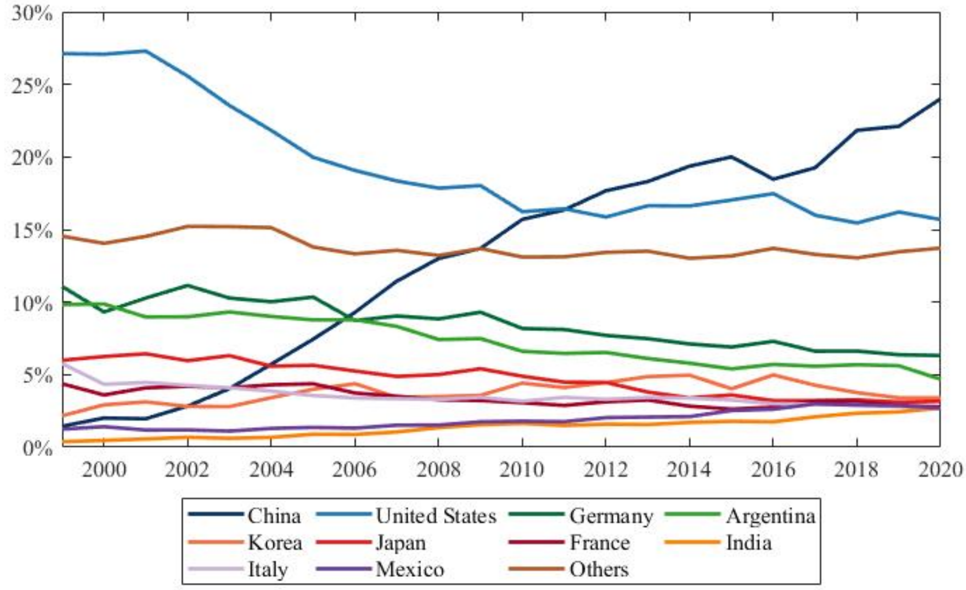


FIGURE 3.2: *Share in Brazilian imports of Intermediate and Capital goods*

Recent results showed that cost shock pass-through at the border is high and close to one. Ahn et al. (2017) analyze the pass through of imported inputs into producer prices at a sector-level. The authors construct an effective imported input price index, based on the sector-level import price index and data from the input-output table, finding a long run pass through of 0.7 for Korea, and a nearly complete pass through for France, Germany and Netherlands. In turn, Berman et al. (2012) find a nearly complete pass-through of exchange rate shocks into import prices, exceeding the pass-through into consumer goods prices.

Cost indexes are rarely employed in empirical analysis of Brazilian inflation. Recently, Pimentel et al. (2020) constructed cost indexes for 21 industrial activities, based on intermediate consumption from the National Accounts. The authors showed the pass-through of positive cost shocks is higher than for the negative cost-shocks in all industries. The result evidences the existence of asymmetry in the pass-through of cost into prices. Prompted by the cost shocks following the outbreak of the COVID-19 pandemic crisis, the Central Bank of Brazil analyzed the impact of costs on inflation in 24 industrial activities BCB (2021). Cost indexes were built by combining the intermediate consumption structure from the Input-Output Matrix released in 2015 with price series from domestic price indexes and imports data. The prices of these industrial activities follow closely the cost indexes. Evidence shows a rapid pass-through of costs into final prices in the manufacturing industry in the period 2005-2020. Still, the pass-through was high and fast in 2020, surpassing what would be expected considering the historical pattern (BCB, 2021).

3.4.2 VARS and SVARS

The study of the propagation of macroeconomic shocks still generates controversy among economists. Since the seminal work ok Sims (1980), Structural Vector Autoregressive (SVAR) have become one of the most used methodologies in empirical research with time series data, in particular in empirical macroeconomic analysis (Kilian and Lütkepohl, 2017). Vector Autoregressive (VAR) models consist of multivariate autoregressions in which each model variable is regressed on its own lags and lags of the other model variables. The innovation vector in a reduced-form VAR, u_t in equation 3.2, represents the innovations of the model, given the information set formed by the lags of the variables in y_t. u_t can also be interpreted as a linear combination of the underlying structural shocks (Gambetti, 2021).

$$y_t = \sum D_p y_{t-p} + u_t \tag{3.2}$$

The reduced-form VAR is therefore the basis for the identification of the economic structural shocks. The vector of structural shocks, w_t in equation 3.3, contains uncorrelated shocks with a well-defined economic interpretation. Many different methods can be used to identify these shocks. Structural Vector Autoregressive models express endogenous variables as a combination of current and past economic shocks. The study of VAR in the structural form allows researchers to quantify causal relations in the data. SVARs therefore provide a useful framework for macroeconomic analysis in which the dynamic response of each variable to economic shocks can be represented by impulse response functions (Gambetti, 2021; Kilian and Lütkepohl, 2017).

$$B_0 y_t = \sum B_p y_{t-p} + w_t \tag{3.3}$$

A common methodology to identify structural shocks is found in the imposition of short-run restrictions through the Cholesky decomposition (Blanchard and Quah, 1988).

As for the domestic variables, we follow a usual ordering found in the empirical literature on of inflation and monetary policy (Sims, 1992), testing alternative orders as robustness check.[7] Considering that Brazil is a price-taker in international markets allows us to assume that Foreign PPI and Commodity Prices are not affected by contemporaneous shocks in the domestic economy. However, we consider that Foreign PPI may be affected by changes in Commodity Prices.

The order of variables adopted in our analysis is expressed in equation 3.4. The model includes 12 lags for each variable since it relies on monthly data. The model's estimate also includes a constant term.

$$B_0 y_t = \begin{pmatrix} - & 0 & 0 & 0 & 0 & 0 \\ - & - & 0 & 0 & 0 & 0 \\ - & - & - & 0 & 0 & 0 \\ - & - & - & - & 0 & 0 \\ - & - & - & - & - & 0 \\ - & - & - & - & - & - \end{pmatrix} \begin{pmatrix} Commodity \\ ForeignPPI \\ InterestRate \\ ExchangeRate \\ CPI \\ GDP \end{pmatrix} \qquad [3.4]$$

[7] Alternatively, we may consider that the information set underlying monetary policy decisions is updated with the contemporaneous variables. We thus consider an alternative ordering of the Cholesky matrix, setting the interest rate as the most endogenous variable to contemporaneous shocks. This robustness test, presented in section 3.6.3, confirms the results obtained here.

3.5 Foreign PPI Shocks and Inflation in Brazil

We tested the hypothesis that Foreign PPI explains domestic CPI for Brazil in the period 1999-2020. Foreign PPI may be an additional transmission channel of external shocks to domestic inflation. Figure 3.3 reports the response of CPI to structural shocks identified in the model.[8] Shocks in Foreign PPI increase the CPI in the first twelve months. The impact of the shocks is weakly reverted in the following periods. Cumulative impulse response functions (figure 3.4) show that the positive effect is persistent over the time horizon. The positive effect is significant within the 90% level until period 13.

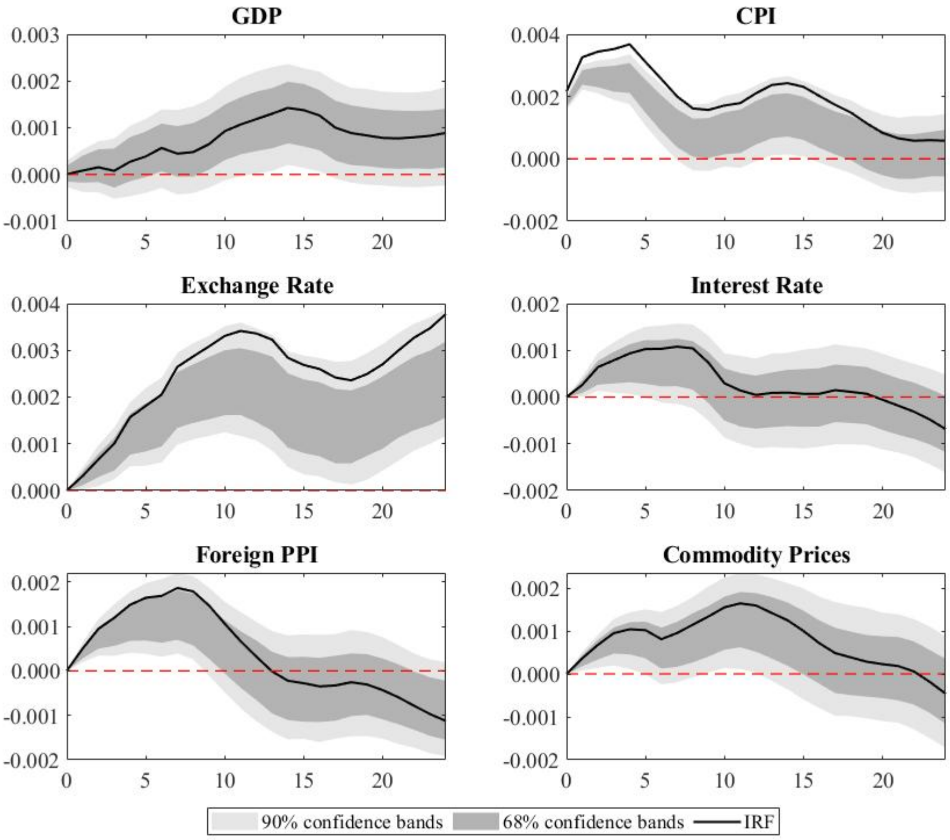


FIGURE 3.3: *Non Cummulative Response of CPI to Structural Shocks*

Note: Non Cummulative Impulse Response Functions of CPI to Shocks in GDP, CPI, Exchange Rate, Interest Rate, Foreign PPI, and Commodity Prices.

Impulse response functions confirm the importance of the exchange rate and

[8] The complete impulse response functions are presented in the appendix.

commodity prices to explain the CPI. Real domestic shocks as measured by the real GDP cause increases in the price level. In the baseline specification, interest rate shocks increase the price level in the whole period, presenting a persistent price puzzle. The significant positive effect of interest rate shocks on CPI means that monetary policy does not show the expected effect in the impulse response functions. However, the expected negative effect reappear (sometimes after a short lived price puzzle) in the impulse response functions when we replace the real GDP with an Industrial Production index or when we drop the extreme observations associated with the COVID-19 pandemic crisis.

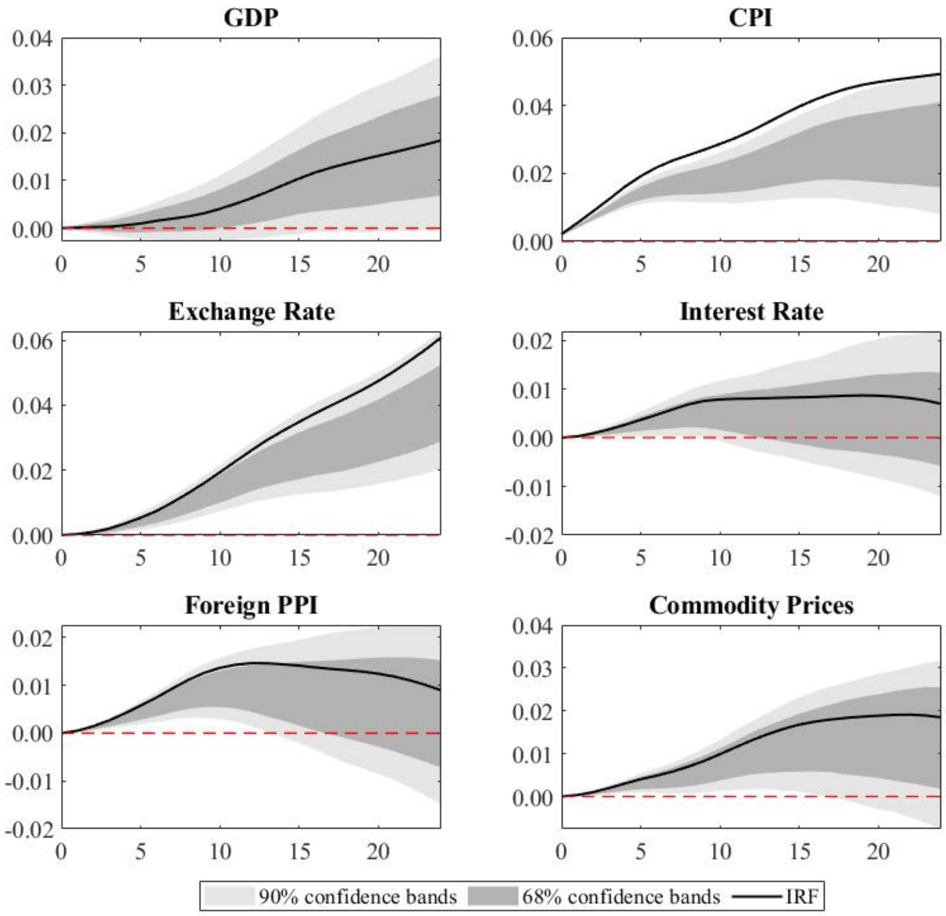


FIGURE 3.4: *Cummulative Response of CPI to Structural Shocks*

Note: Cummulative Impulse Response Functions of CPI to shocks in GDP, CPI, Exchange Rate, Interest Rate, Foreign PPI, and Commodity Prices.

In addition to the impulse response functions, the Structural VAR methodology allows us to describe how much of the forecast error variance (or prediction mean squared error) of the dependent variable is accounted for by each structural shock at different time horizons (Kilian and Lütkepohl, 2017; Kilian and Park, 2009).

Table 3.3 reports the forecast error variance decomposition for CPI. Foreign PPI shocks account for 11.03% of the forecast error variance of Brazilian inflation at the 12-month horizon. Its explanatory power decreases to 7.47% at the 36-month horizon. It is noteworthy that until the 36-month horizon, Foreign PPI shocks are approximately as important as Commodity Prices shocks to explain the forecast error variance of CPI. The results confirm that the Exchange Rate shocks have the largest explanatory power over the variance of CPI. Exchange Rate shocks account for 31.29% of the forecast error variance at the 12-month horizon, and for 54.40% of the forecast error variance at the 36-month horizon. In the long run, almost half of the variance of Brazilian inflation is explained by the exchange rate.

TABLE 3.3: Forecast Error Variance Decomposition for CPI.

Time Horizon	GDP	CPI	Exchange Rate	Interest Rate	Foreign PPI	Commodity Prices
12	1.82	45.02	31.29	3.71	11.03	7.13
24	4.91	34.11	45.87	2.14	6.76	6.23
36	5.14	19.08	54.40	5.54	7.47	8.37
120	13.14	11.79	47.75	15.07	10.18	22.08

Percentage of Ahead Forecast Error Variance Explained by structural shocks on GDP, CPI, Exchange Rate, Interest Rate, Foreign PPI, Commodity Prices at the respective time horizon.

Figure 3.5 plots the historical decomposition of the stochastic component of CPI according to the structural shocks. Shocks related to the external sector (captured by the variables Exchange Rate, Foreign PPI, and Commodity Prices) dominated the explanation of the stochastic component of the CPI series. The exchange rate presented an outstanding role, confirming the results of previous research. This variable responded for 27.17% of the total shocks affecting CPI. The CPI itself responded for 29.0% of the shocks. Foreign PPI shocks explain 12.05% of the stochastic component of CPI in the period. Finally, GDP, Interest Rate, and Commodity Prices represented, respectively, 10.17%, 7.87%, and 13.75%. The monetary policy instrument presents the weakest effect on the CPI series. However, monetary policy becomes much more effective once we consider that it also operates through the exchange rate effect.

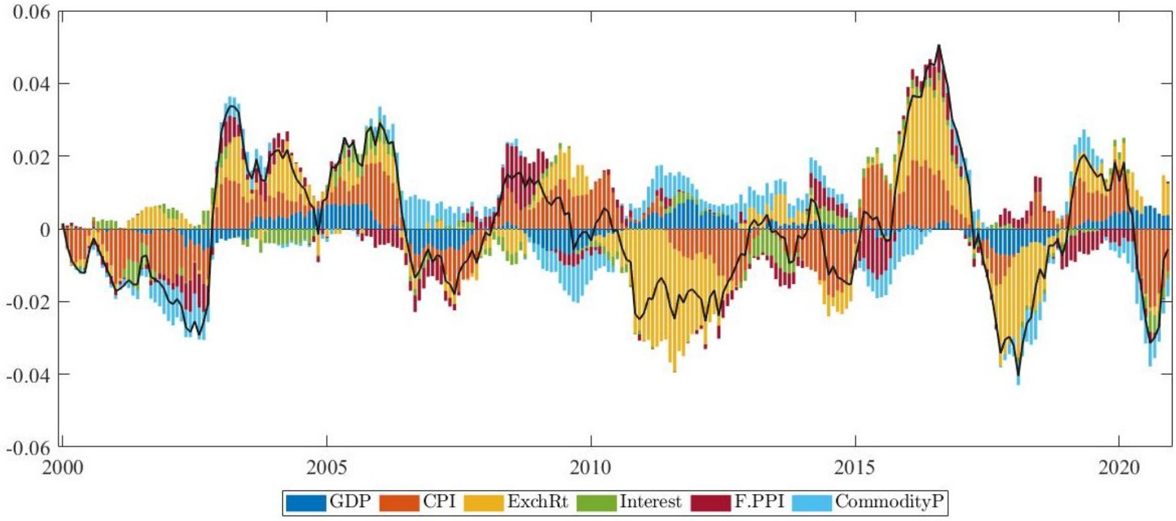


FIGURE 3.5: *Historical Decomposition of CPI according to shocks on GDP, CPI, Exchange Rate, Interest Rate, Foreign PPI, and Commodity Prices.*

We conclude that international shocks have been fundamental to explain inflation in Brazil in the last decades. In particular, shocks on producer prices of Brazil's trade partners are shown to be a relevant transmission mechanism of international shocks to domestic inflation. Impulse response functions show that Foreign PPI has a positive and significant effect on domestic CPI. Foreign PPI shocks are also an important explanation of the variance of CPI's forecast error, especially in the short-term. Historical decomposition confirmed the relative importance of the effect of Foreign PPI shocks on CPI. We will show in the next section that this result is robust to alternative specifications and change in variables.

The prominent role of shocks related to the external sector undermines the power of monetary policy to control inflation. The only effective instrument to avoid the transmission of international shocks is the appreciation of the exchange rate. This variable, however, must be defined according to a broader policy perspective, since it affects financial stability, besides of interacting with distribution and trade (Nassif et al., 2020). Therefore, our results seem to confirm that the inflation targeting regime relied on the exchange rate effect of contractionary monetary policy. Finally, the pass through of foreign costs shocks into final prices may be avoided through the stabilization of domestic basic input prices. In Brazil, a great deal of basic input prices are monitored by the government or are directly set by state owned companies. Such prices may be key to mitigate the volatility coming form foreign shocks.

3.6 Robustness Analysis

We performed different analyses to test the robustness of the results of the baseline model. We tested if results are robust to (a) replacing real GDP with an Industrial Production index; (b) dropping the observations of 2020 (due to the pandemic crisis) from the sample; (c) making monetary policy the most endogenous variable in the identification of the contemporaneous shocks; (d) estimating the impulse response functions with local projections.

The sign of the expected effect of shocks in Foreign PPI on CPI did not change in these analyses. The magnitude of the effect became smaller in specification (a), and greater in specification (c). Foreign PPI shocks are shown to have a persistent positive effect on CPI in most cumulative impulse response functions. The main conclusions of the model are therefore robust to changes in the variable measuring real domestic shocks, dropping extreme observations related to the pandemic crisis and changing the recursive ordering of structural shocks. Local projections estimate showed a positive and significant effect only in the initial periods, but this effect soon becomes non significant afterward.[9] This shows a permanent effect of the cost shock on prices, which occurs in the initial periods following the shocks but persists over time (with a widening confidence interval).

3.6.1 Industrial Production

We tested if the results are robust to the use of an index of industrial production as a measure of domestic real shocks rather than the GDP. Industrial production index is often preferred in the literature (Gertler and Karadi, 2015; Ramey, 2016), since it is a volume index measured in a monthly basis while a monthly GDP series relies on the interpolation of quarterly series. Nevertheless, in the particular case of Brazil, the real GDP series provides a longer time horizon, which allowed us to estimate the model from 1999-2020. In contrast, the index of industrial production dates back to 2002, reducing the sample size to 228 observations.

Figure 3.7 plots the industrial production index in the period 2002-2020. The series is released by the Brazilian Bureau of Geography and Statistics (IBGE).

[9] Future research may explore Bayesian Local Projections estimate to improve the efficiency of the impulse response functions.

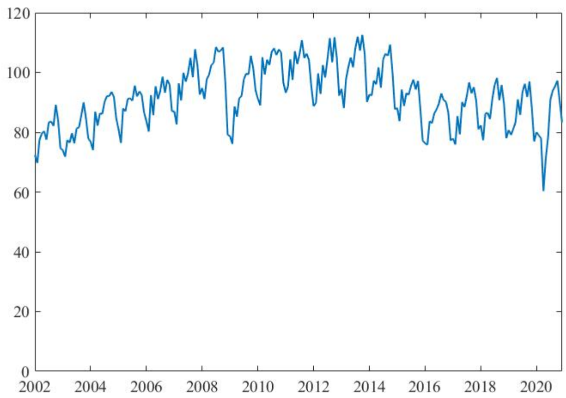


FIGURE 3.6: *Industrial Production*

Impulse response functions show that the results obtained in the baseline model are robust to the substitution of real GDP with a series of Industrial Production. Foreign PPI shocks have a positive effect on CPI. The non cumulative impulse response converges to zero. The cumulative effect of Foreign PPI shocks on CPI is positive and persistent, as shown in figure 3.7. The cumulative effect is significant at the 90% level until the 12th month following the shock. Appendix D reports the complete impulse response functions.

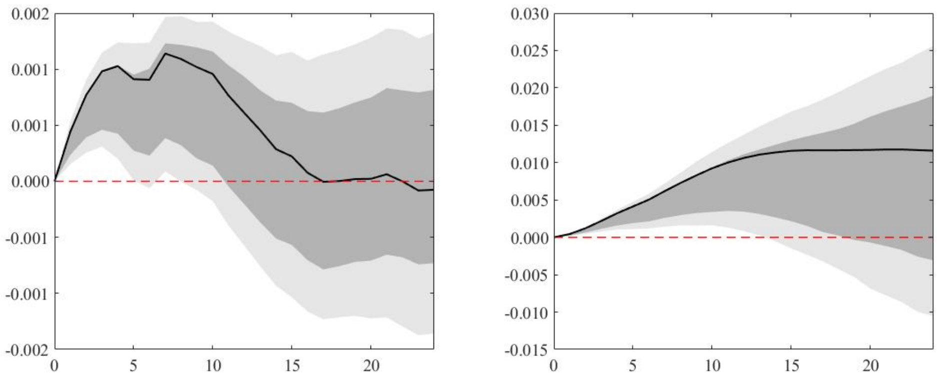


FIGURE 3.7: *Non cumulative (left) and cumulative (right) response of CPI to shocks on the Foreign PPI.*

3.6.2 COVID Shocks

The COVID-19 pandemic engendered the deepest recession of the last decades. The outbreak of the pandemic crisis thus generated a sequence of extreme observations after March 2020. The pandemic shocks caused an immediate fall in international trade, disruption in Global Value Chains, sharp changes in commodity prices, and a huge depreciation of the Brazilian currency (Hevia et al., 2020; Kohlscheen et al., 2020). The huge data variation in the months following the pandemic outbreak constitutes a challenge for the estimation of parameters of VAR models (Lenza and Primiceri, 2020). Dropping the extreme observations related to the pandemic can be an alternative for parameter estimation in time series analysis (Lenza and Primiceri, 2020). Nevertheless, dropping such observations can harm the predictive power of the model, since it underestimates the variance of the Data Generating Process.

We therefore test if the observations following the pandemic crisis affect the conclusions of the baseline model. Hence, we dropped the observations of 2020, remaining with a dataset of 252 observations. We then reestimated the model with the reduced sample by following the same procedure as in the baseline model. Figure 3.8 shows the response of CPI to Foreign PPI shocks in the new estimate. The complete impulse response functions are reported in the appendix.

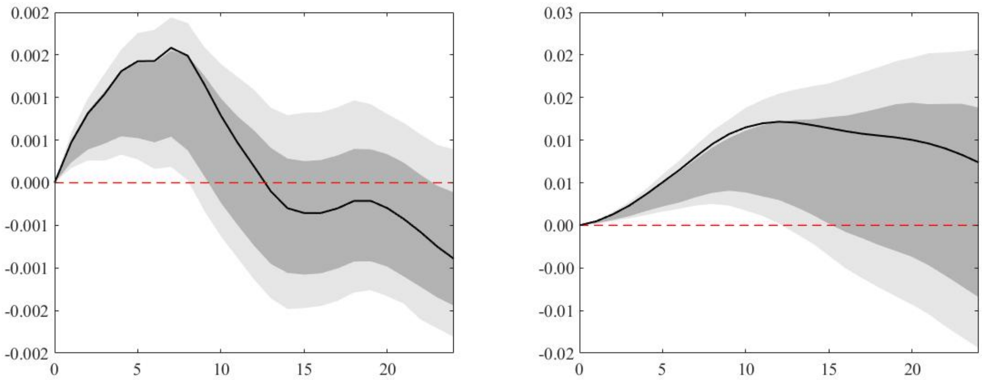


FIGURE 3.8: *Non cumulative (left) and cumulative (right) response of CPI to shocks on the Foreign PPI.*

We conclude that our main result is robust to the drop of the extreme observations following the pandemic crisis. Foreign PPI still presents a positive and significant effect on CPI. The response of CPI to Foreign PPI shocks becomes negative, but not significant from the 13th period onward. Notwithstanding this change in sign, the cumulative effect remains positive in the 24 months horizon, and significant at the 90% level until the 12th month after the shock.

3.6.3 Monetary Policy

The baseline model relied on the recursive ordering of the orthogonalized shocks as described in section 4.3. The ordering imposed that Foreign PPI and Commodity Prices are not affected by domestic contemporaneous shocks. That assumption ensured that real international shocks are independent from contemporaneous domestic shocks. However, this strategy has the downside of assuming that monetary policy has a delayed response to domestic shocks.

The recursive ordering of structural shocks in VARs models usually considers that monetary policy respond contemporaneously to both domestic and external shocks, but has a lagged effect on these variables. Therefore, the standard identification strategy imposes zero contemporaneous restrictions to the monetary policy variable (Christiano et al., 1998). In fact, Central Banks are likely to consider a broader informational set, anticipating the impact of economic events before they affect the meaningful variables (Romer and Romer, 2000; Sims, 1992).

We therefore test if the results from the baseline model are robust to the change in the identification of structural shocks. Namely, we reordered the Cholesky matrix, setting the Interest Rate as the most endogenous variable to contemporaneous shocks. Figure 3.9 report the response of CPI to Foreign PPI shocks in the alternative specification of the model.

Impulse response functions show that the effect obtained in the baseline model is robust to the alternative specification. The sign of the effect of Foreign PPI shocks on CPI follows the expected result. The impulse response follows a similar patter as in the baseline case, with an initial increase in CPI, stabilizing in a longer time horizon. The effect is has a greater magnitude with respect to the baseline model. The positive effect is significant (at the 90% level) until eight periods following the shocks in the non cumulative impulse response function. The cumulative impulse response function reveals a positive and significant effect until the 12th period after the shock. The complete impulse response functions can be found in Appendix D.

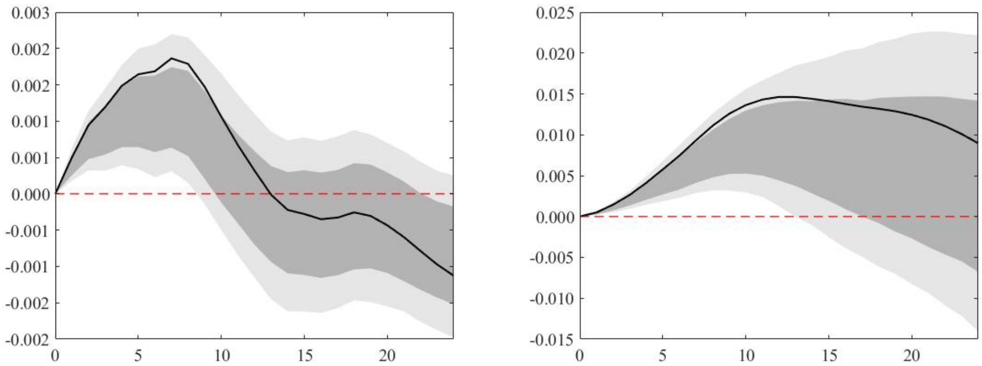


FIGURE 3.9: *Non cumulative (left) and cumulative (right) response of CPI to shocks on the Foreign PPI.*

3.6.4 Local Projections

Local projection estimations can be employed to test the robustness of impulse response functions estimated by VARs. Jordà (2005) introduced local projections as an alternative method to Structural VARs. Local projections are robust to misspecification of the Data Generating Process. If the VAR adequately captures the data generating process, it is the optimal model to recover impulse responses at all horizons. However, if the VAR is misspecified, then the specification errors will be compounded at the increasingly distant horizons of the impulse response functions (Jordà, 2005). Alternatively, Jordà (2005) suggests collecting projections local to each forecast horizon. Local projections are analogous to performing a series of direct forecasts, while the VAR method is analogous to the iterated forecasting method (Ramey, 2016). Once local projections impose fewer restrictions than VAR models, "the estimates are often less precisely estimated and are sometimes erratic. Nevertheless, this procedure is more robust than standard methods, so it can be very useful as a heuristic check on the standard methods." (Ramey, 2016). We thus tested the robustness of our results by estimating the local projections impulse response function.

We estimated the impulse response of CPI to Foreign PPI shocks at the horizon h according to the following model:

$$CPI_{t+h} = \theta_{i,h}\epsilon_{1t} + ControlVariables_t + \zeta_{t+h} \qquad [3.5]$$

ϵ stands for the Foreign PPI shocks. Shocks were recovered by means of a Structural

VAR model that regressed Foreign PPI against Commodity Prices. Foreign PPI shocks are therefore the structural residuals of the Foreign PPI equation. $ControlVariables$ include a deterministic term (constant), the lagged dependent variable (CPI) and current and lagged variables included in the baseline model (that is, GDP, Interest Rate, Exchange Rate, Commodity Prices). We used a lag length of 12 periods for the shock, the dependent variable and the controls. Local projections may generate serial correlation in the error terms owing to the successive leading of the dependent variable (Jordà, 2005). Therefore, we use the Newey-West correction for the standard errors (Newey and West, 1987).

Figure 3.10 plots the impulse response function of Foreign PPI shocks on CPI. Impulse response function shows a initial positive and significant effect smoothed in the following periods. The cumulative impulse response shows a positive, although it is significant only in the initial periods following the shock. We conclude that estimating the impact of Foreign PPI shocks on CPI with Local Projections method provides the expected sign, as in the baseline model. However, widening confidence intervals make the effect non significant after the initial periods following the shock. In fact, local projections are likely to be less efficient than iterated methods, thereby being subject to volatile and imprecise estimates (Ramey, 2012). Future research may improve the identification of Foreign PPI shocks and estimate with a more efficient methodology as Bayesian Local Projections (Miranda-Agrippino and Ricco, 2021).

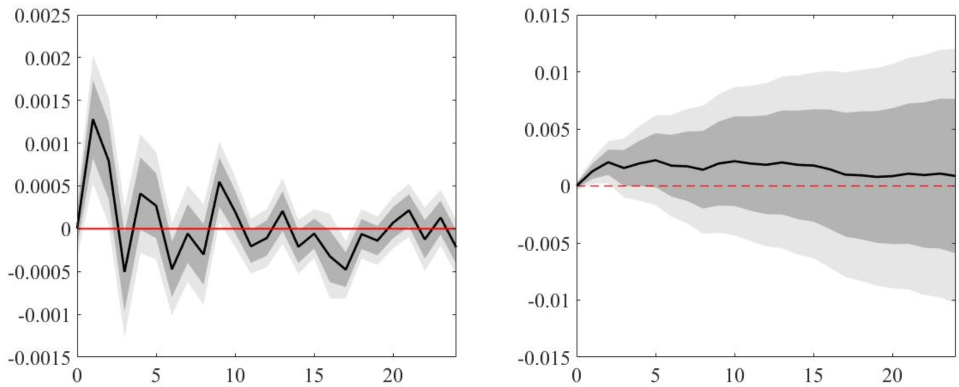


FIGURE 3.10: *Non cumulative (left) and cumulative (right) response of CPI to shocks on the Foreign PPI.*

3.7 Final Remarks

We analyzed if cost shocks in the rest of the world affect inflation in Brazil. The effect of foreign producer price shocks had not been addressed by the literature on Brazilian inflation yet, although the effect was tested for other countries (Auer et al., 2019; Auer and Mehrotra, 2014). To measure foreign producer price shocks, we built a Foreign PPI according to the producer price indexes of Brazilian trade partners and their share on Brazilian imports of intermediate and capital goods. Impulse response functions confirm the expected effect of the Foreign PPI on the domestic CPI. Impulse response functions also confirmed the overall importance of exchange rate and commodity prices as explanations of CPI. We conclude that the index measuring international cost shocks was a significant transmission channel of external shocks to domestic CPI in Brazil in the last two decades. The result is robust to the replacement of GDP with an Industrial Production index, dropping the observations related to the pandemic crisis, and making monetary policy the most endogenous variable in the identification of the contemporaneous shocks. Local Projections estimate of impulse response functions shows the expected sign, although the result becomes non-significant a few periods after the shock.

Overall, our results reveal the dominance of shocks related to the external sector (Exchange Rate, Foreign PPI, and Commodity Prices) over domestic shocks (GDP and Interest Rate) to explain inflation in Brazil. The importance of international shocks and of Foreign PPI in particular has important implications for monetary policy. International shocks are not affected by the policy rate pegged by the Central Bank of Brazil. However, the impact of these shocks on Brazilian prices also depend on the exchange rate. Therefore, our results seem to confirm that the inflation targeting regime relied mainly on the exchange rate effect of interest rate increases, confirming previous results. Finally, this chapter provides an additional variable explaining the effect of external shocks on domestic inflation in Brazil.

Appendix

A Unit Root tests

The table below presents test statistics and p-values for levels unit root tests.

TABLE A.1: Unit Root tests in levels

Variable	**Test Statistic ADF**	**P-value ADF**	**Test Statistic PP**	**P-value PP**
GDP	−0.6769	0.9717	1.4063	0.9900
CPI	−1.8219	0.6509	−4.7095	0.8461
ExchangeRate	−1.4474	0.8086	−3.3310	0.9189
InterestRate	−3.7174	0.0236	−10.4646	0.5232
ForeignPPI	−1.5936	0.7471	−3.9482	0.8889
CommodityPrices	−1.5003	0.7864	−4.6251	0.8509

TABLE A.2: Unit Root tests in first difference

Variable	**Test Statistic ADF**	**P-value ADF**	**Test Statistic PP**	**P-value PP**
GDP	−3.5300	0.0403	−51.4616	0.01
CPI	−5.8647	0.01	−102.6247	0.01
ExchangeRate	−6.1267	0.01	−191.1040	0.01
InterestRate	−7.1256	0.01	−41.1915	0.01
ForeignPPI	−6.0357	0.01	−126.9793	0.01
CommodityPrices	−6.2574	0.01	−191.5341	0.01

B Cointegration Analysis

TABLE B.3: Johansen trace test

H_0	**Test Statistic**	**10%**	**5%**	**1%**
$r \leq 5$	0.32	6.50	8.18	11.65
$r \leq 4$	8.26	15.66	17.95	23.52
$r \leq 3$	19.23	28.71	31.52	37.22
$r \leq 2$	41.49	45.23	48.28	55.43
$r \leq 1$	81.82	66.49	70.60	78.87
$r = 0$	136.40	85.18	90.39	104.20

C Baseline Model

Impulse Response Functions

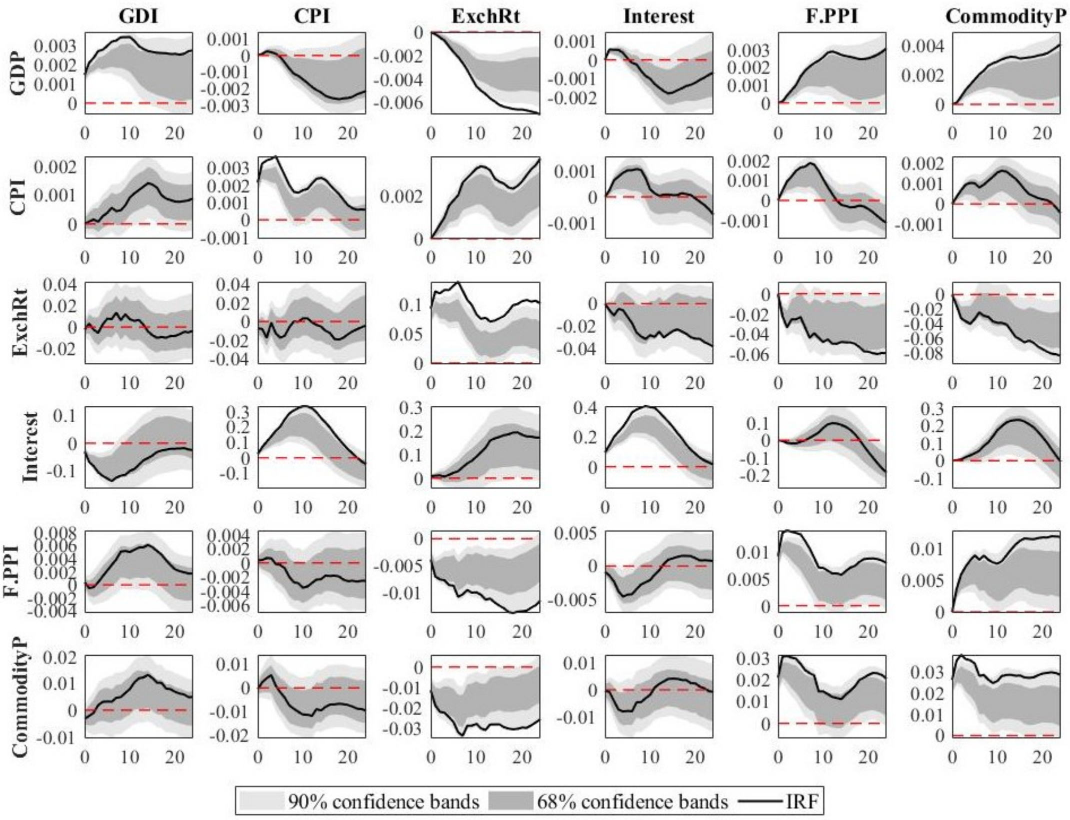


FIGURE 3.11: *Non Cummulative Impulse Response Functions of the Baseline Model*

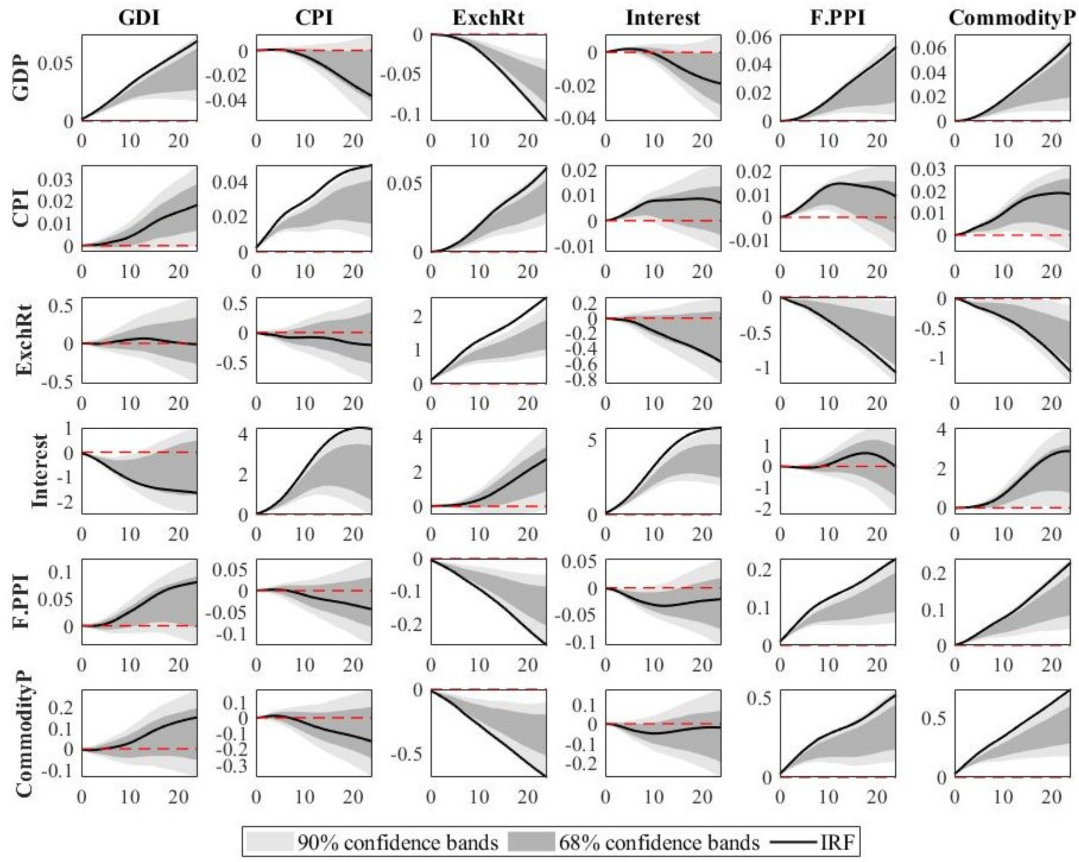


FIGURE 3.12: *Cummulative Impulse Response Functions of the Baseline Model*

Forecast Error Variance Decomposition

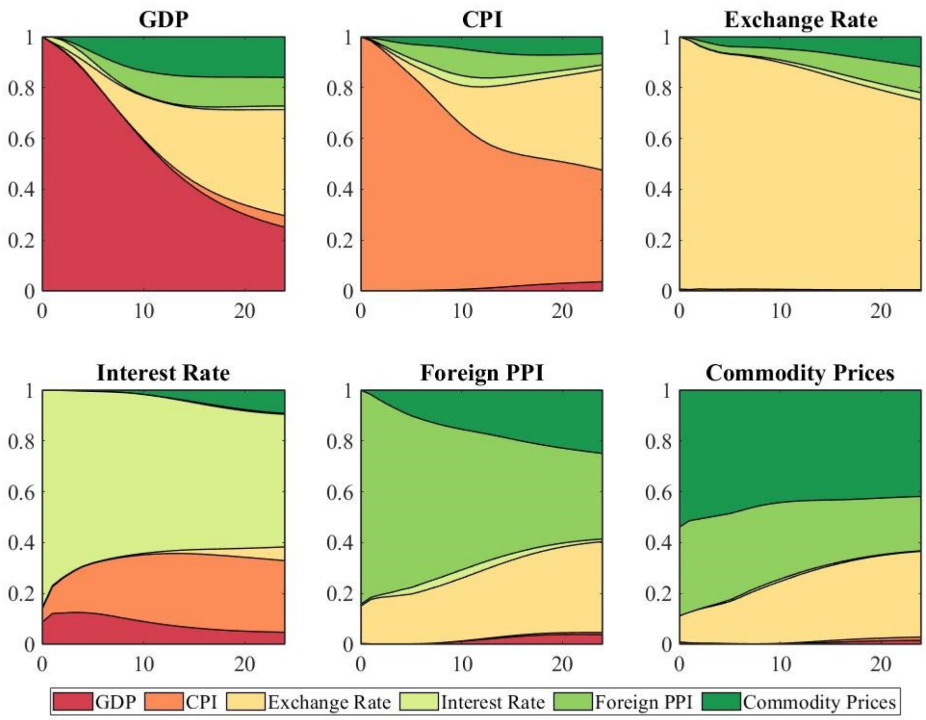


FIGURE 3.13: *Forecast Error Variance Decomposition of the Baseline Model*

D Impulse Response Functions of the Robustness Tests

Industrial Production

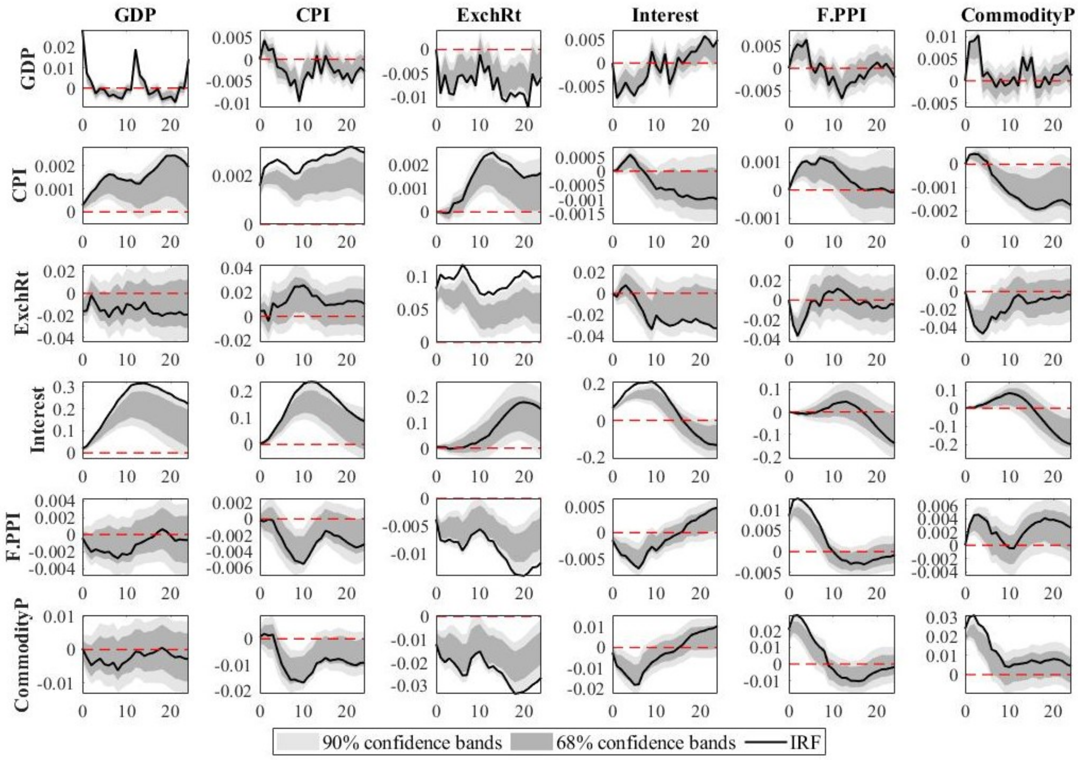


FIGURE 3.14: *Non Cumulative Impulse Response Functions*

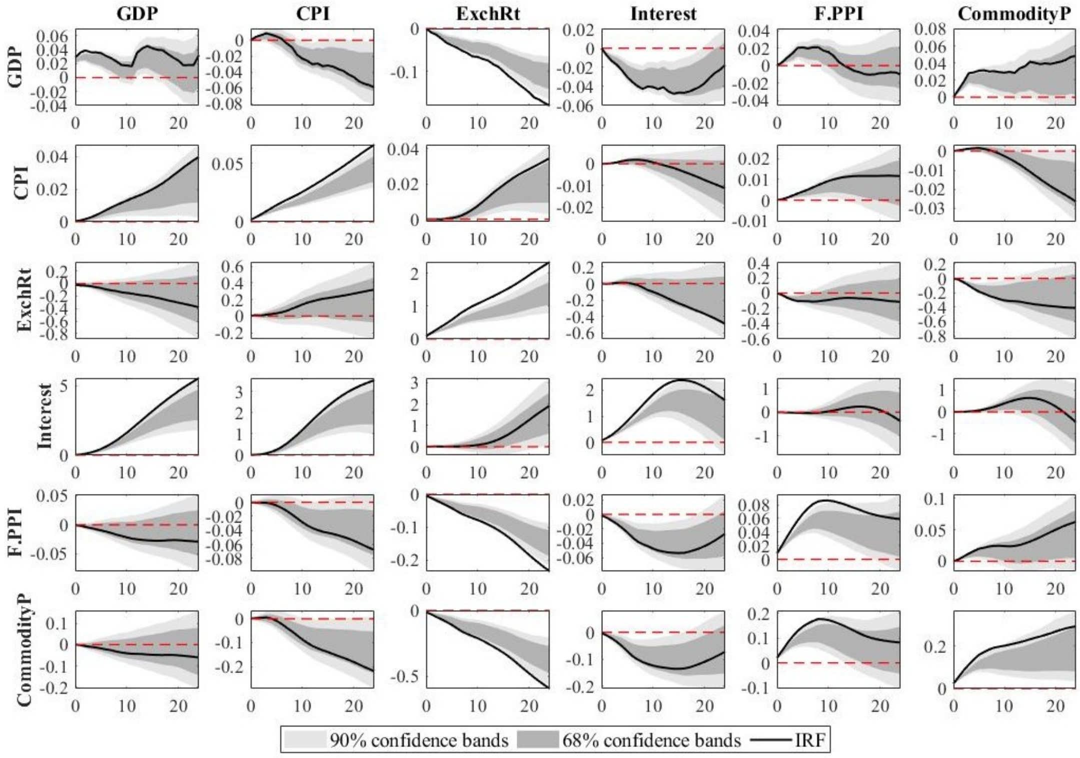


FIGURE 3.15: *Cumulative Impulse Response Functions*

COVID

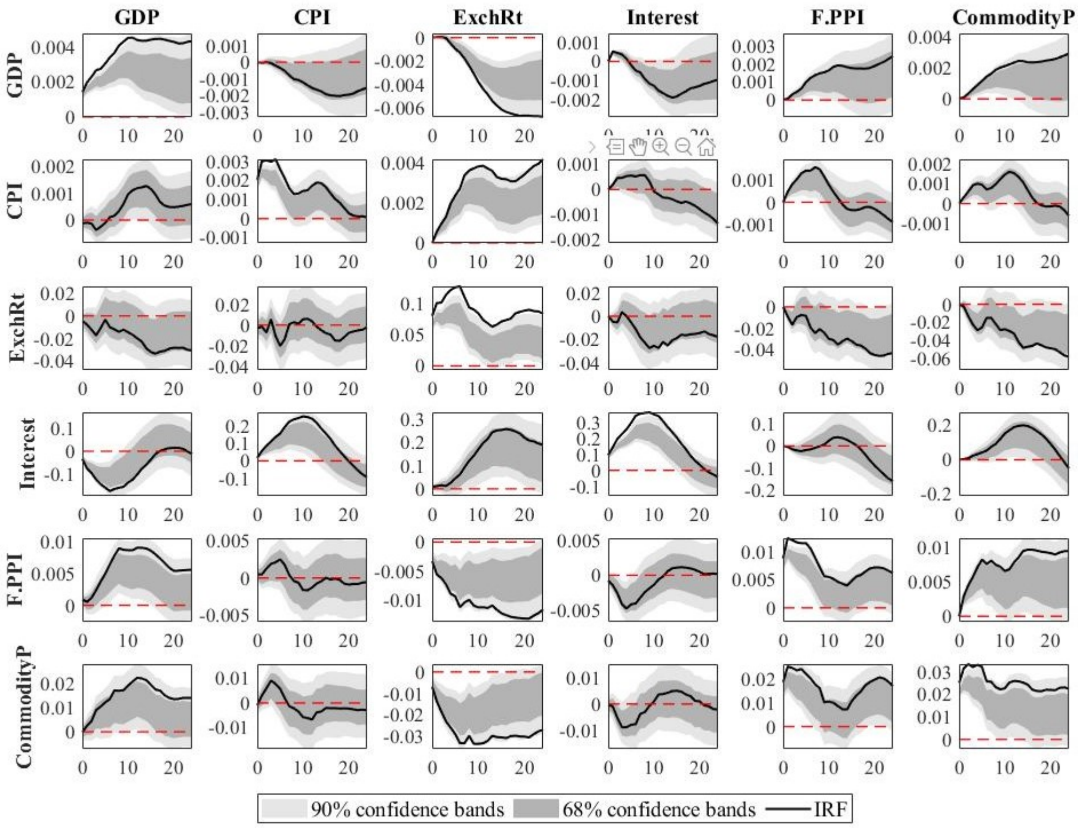


FIGURE 3.16: *Non Cumulative Impulse Response Functions*

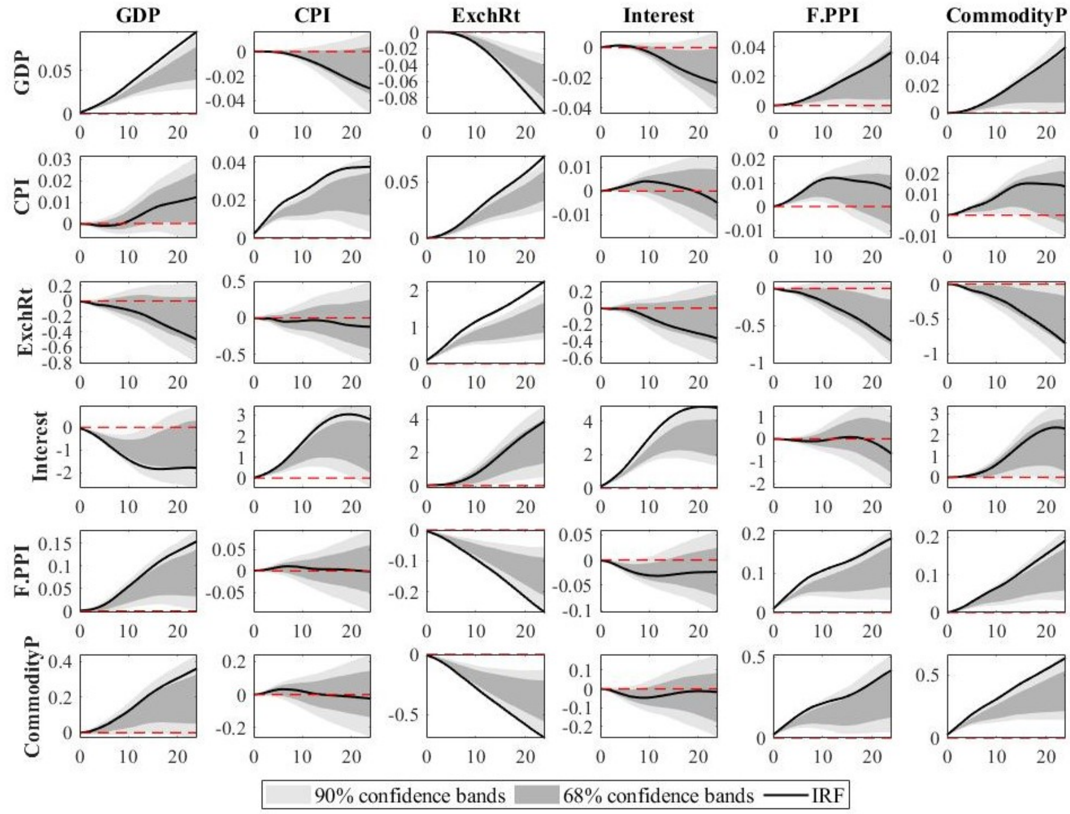


FIGURE 3.17: *Cumulative Impulse Response Functions*

Monetary Policy

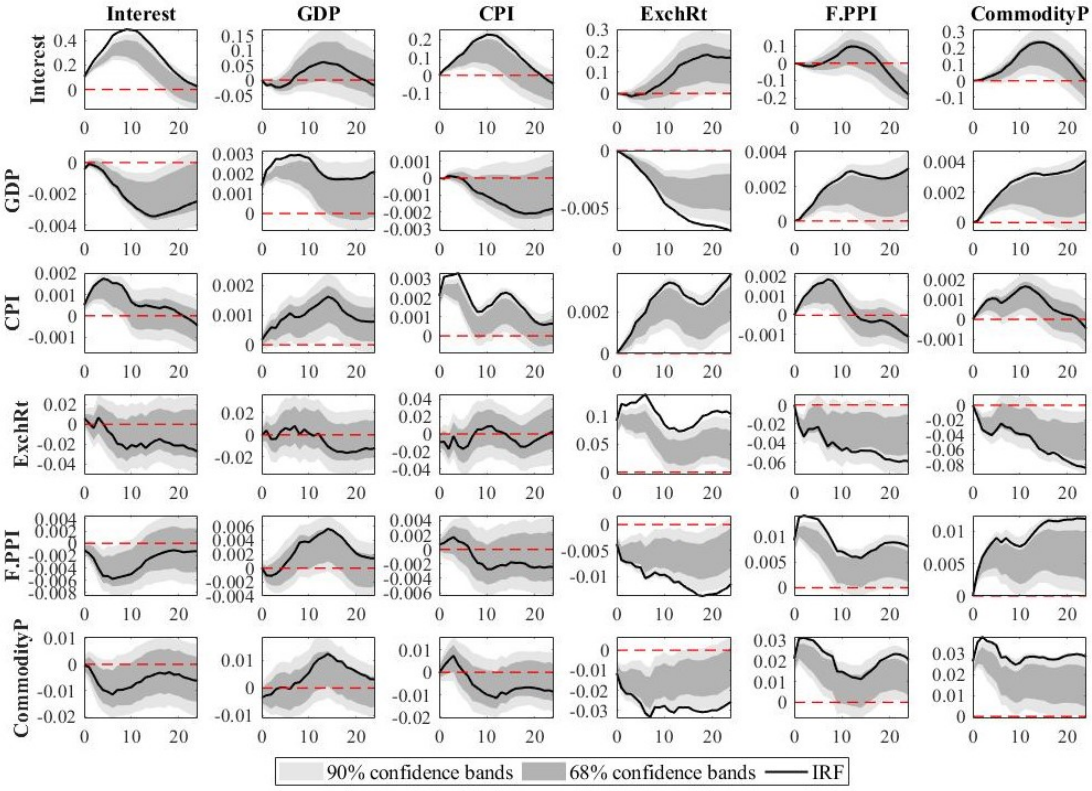


FIGURE 3.18: *Non Cumulative Impulse Response Functions*

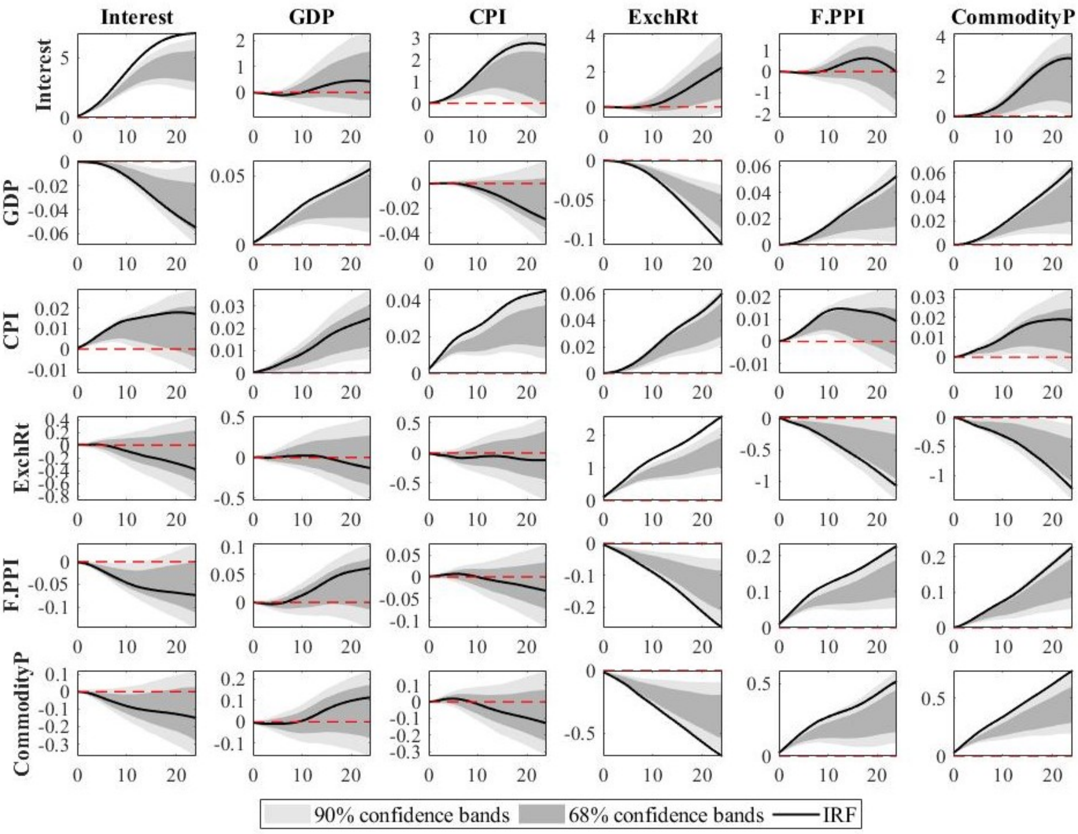


FIGURE 3.19: *Cumulative Impulse Response Functions*

Chapter 4

Growth and debt stability in a supermultiplier model with public expenditures and foreign trade

4.1 Introduction

Post-Keynesian Economics assigns a prominent role to government and foreign trade as drivers of demand. Government spending and exports are typical examples of "external markets" (Kalecki, 2016), fundamental for the absorption of growing output in capitalist economies. External to the capitalist income circuit, these expenditures can be defined as autonomous demand (Cesaratto, 2015). In the Sraffian supermultiplier class of models, autonomous expenditures are the ultimate drivers of demand and growth. Because of this key role, they must be carefully appreciated. Thus, we investigate two dimensions of the sustainability of foreign trade and government spending. The first one concerns the balance of payments and the external constraint, and the second, the long-run stability of public finance.

The Sraffian supermultiplier provides a useful framework for analyzing the consequences of autonomous demand to economic growth (Freitas and Serrano, 2015; Serrano, 1995a). The supermultiplier literature has discussed growth models led by different sources of autonomous demand (Allain, 2015; Hein, 2018; Lavoie, 2016; Nah and Lavoie, 2017; Nomaler et al., 2021). However, growth in the supermultiplier depends on the long-run sustainability of the financial stocks behind the autonomous components of aggregate demand (Hein and Woodgate, 2020; Pariboni, 2016b). Steady growth in an open economy with government thus requires the stability of the financial imbalances of the public and the external sectors.

This chapter aims to analyze the sustainability of growth led by exports and public expenditure. Hence, we examine the stability of external and public debt ratios in a supermultiplier model with exports and public expenditure. Debt ratios are stable when the growth rates (of output or exports) are larger than the interest rates on the (public or external) debt service. Nevertheless, the growth of public expenditures may threaten the stability of the external debt in the presence of international financial constraints. Therefore, we propose a fiscal policy rule that contains foreign indebtedness. Five simulated experiments support the analytical conclusions of the model and compare policy alternatives.

We contribute to the Sraffian supermultiplier literature by modeling an open economy with government and assessing the sustainability of its growth path. Differently from most of the supermultiplier literature, we explicitly introduce more than one autonomous expenditure and allow for changes in the composition of autonomous demand. We also contribute to the literature on growth and the external constraint (Barbosa-Filho, 2001; Moreno-Brid, 1998; Thirlwall, 1979) by discussing how this constraint emerges in an open economy supermultiplier model. Thirlwall's Law reappears as an upper limit to growth in the long run. Nonetheless, introducing a domestic autonomous expenditure implies that the external constraint is not always binding given that demand is not driven only by exports. Finally, we show that treating the external constraint as a long run debt-stability condition also may relax this constraint in the short run, which confirms the importance of an out of the steady-state analysis.

The remainder of this chapter is structured as follows. Section 2 presents the Sraffian supermultiplier growth model, describing its contribution to demand-led growth theory. Section 3 extends the model for an open economy with government, in which exports and public expenditure compose autonomous demand. Section 4 discusses public and external debt stability in demand-led approaches. The same section introduces debt dynamics in the model, defining the equilibrium values for debt ratios and the conditions for their stability. The section also proposes a fiscal policy rule, and compare the results for external debt with Thirlwall's tradition. Section 5 presents the simulations of the model, exploring five different experiments. A final section summarizes the main findings of the chapter.

4.2 The Sraffian supermultiplier

The Sraffian Supermultiplier is a contribution to demand-led growth theory originally proposed by Serrano (1995a, 1996b), extended lately by Freitas and Serrano (2015) Serrano and Freitas (2017). By highlighting the role of autonomous components of aggregate demand that do not generate productive capacity, the Sraffian Supermultiplier coped with long-lasting shortcomings of demand-led models of growth. In particular, this framework generates an endogenous convergence of the degree of capacity utilization towards normal capacity without necessarily triggering Harrodian instability neither relying on endogenous adjustments in income distribution. For this reason, the supermultiplier has achieved greater acceptance within the demand-led growth tradition, being endorsed by some Kaleckian scholars (Allain, 2015; Dutt, 2019; Hein, 2018; Lavoie, 2016).

The Sraffian supermultiplier combines an exogenous determination of distribution and an investment function following the capital stock adjustment principle in a stable path of growth which ensures convergence towards normal capacity. The exogenous determination of distribution means that the model does not require any functional relation between growth and distribution. Assuming distribution is exogenous to growth means that the supermultiplier model can be integrated with the Classical surplus approach to value and distribution. This approach analytically distinguishes the theory of value and distribution from the theory of output and accumulation (Garegnani, 1984). In this view, political and institutional factors, together with economic factors, explain income distribution (Pivetti, 1991; Sraffa, 1960; Stirati, 1994). This feature of the supermultiplier contrasts with the Cambridge growth model, in which movements in functional income distribution allow for the equilibrium between aggregate savings and investment.

In the Sraffian supermultiplier, investment adjusts to effective demand, in a way similar to the accelerator investment function originally proposed by Harrod (1939). In simple terms, the accelerator suggests that increases in productive capacity are a consequence of higher use of existing capacity. Firms regularly operate with spare capacity, thereby being able to attend to unexpected peaks of demand. Technical conditions of productive efficiency define a degree of capacity utilization labeled as the normal degree (Ciccone, 1986, 2011). If sales increase, capacity utilization will also increase. If firms expect demand to remain persistently higher, they will expand production capacity by investing in capital goods. It is noteworthy that the introduction of the adjustment of capacity to demand does not necessarily trigger an unstable pattern in the supermultiplier, in which it differs from Harrod's growth model.[1] Harrodian

[1] See Freitas and Serrano (2015) for an analysis of the stability condition of the Sraffian supermultiplier. Estimating the model's parameters for the US economy, Haluska et al. (2020) shows that Harrodian

instability is solved with the presence of autonomous expenditures, which adjust the economy's average propensity to save to the investment share in output (Freitas and Serrano, 2015; Serrano et al., 2019). Harrodian instability is also avoided due to the assumption of a slow adjustment of capacity to demand (Freitas and Serrano, 2015). Contrasting with Neo-Kaleckian growth models, in the Supermultiplier, there is no direct relation between distributive variables (as profit rate) and investment. Hence, a shift in distribution in favor of profits that is not followed by an increase in demand (and, thus, use of capacity) will not push investment in this model.[2]

The main conclusion of the Sraffian supermultiplier posits that the growth rate of non-capacity generating autonomous expenditures determines the growth rate of aggregate demand, productive capacity, and output in the long run (Serrano, 1995b). Demand drives output growth and capital accumulation, fitting in with desirable features of a demand-led growth model.[3] Putting it differently, the supermultiplier is consistent with the Keynesian Hypothesis – *i.e.*, the notion that "in the long period, in which productive capacity changes, no less than in the short period analyzed by Keynes, it is an independently determined level of investment that generates the corresponding amount of savings, rather than an autonomous propensity to save that generates the level of investment as in the traditional answer" (Garegnani, 1992, p. 47). Finally, capacity utilization converges towards an exogenous normal degree of capacity utilization in a stable process.

The Sraffian Supermultiplier has stimulated the debate among heterodox macroeconomists in the past few years (Allain, 2015; Cesaratto, 2015; Lavoie, 2016). As the model achieved greater acceptance as a relevant contribution to demand-led growth theory, further developments were introduced into the original framework. Neo-Kaleckian scholars advanced an alternative version of the model, preserving an autonomous parameter as a determinant of investment — together with deviations in capacity utilization — in the short and the medium-run (Lavoie, 2016). This parameter is often associated with capitalists 'animal spirits' (Amadeo, 1986). The long-run of this Neo-Kaleckain supermultiplier coincides with the fully adjusted position of Serrano's (1995a) model. Furthermore, different sources of autonomous demand, as public expenditures (Allain, 2015; Hein, 2018) and exports (Nah and Lavoie, 2017) were introduced in the supermultiplier model. Fiebiger and Lavoie (2019); Pariboni (2016b) discussed connections between autonomous (or semi-autonomous) private

instability is unlikely to happen in the supermultiplier.

2 See Pariboni (2016a) for a critique to the Neo-Kaleckian growth model in light of the Sraffian supermultiplier. Another divergence from the Neo-Kaleckian growth model lies in the (univocal) convergence of capacity utilization towards the normal degree of capacity utilization (Girardi and Pariboni, 2019).

3 In the supermultiplier, the autonomous components of demand are the proximate cause of growth. Nevertheless, the ultimate causes of growth in the supermultiplier are not found in the intricacies of economic modeling but in the political and social determinants of autonomous demand (Morlin et al., 2021; Passos and Morlin, 2020).

consumption and financial variables. Brochier and Silva (2019); Cassetti et al. (2017); Mandarino et al. (2020) approached the supermultiplier in a stock-flow consistent framework. Fazzari et al. (2020); Palley (2019) discuss unemployment and labor market concerns in light of the Sraffian supermultiplier growth model.

Few works have explicitly dealt with models with two sources of autonomous demand. With different objectives, Freitas and Christianes (2020) and Hein and Woodgate (2020) account for private consumption and public expenditure. Pariboni (2016b) studies how changes in one (non-specified) autonomous expenditure affects the stability of private debt associated with autonomous consumption. In the current chapter, we develop a supermultiplier model with two sources of autonomous demand: public expenditure and exports. We show how these expenditures determine the growth path in a fully adjusted position and discuss the long-run conditions of public and foreign debt sustainability.

4.2.1 Sraffian superrmultiplier model

After this summary, we can present the basic analytical framework proposed by Serrano (1995b) of the Sraffian supermultiplier as a demand-led growth model. I follow the exposition of Freitas and Serrano (2015) closely.

Let us start by introducing some useful relations. In this framework, the level of output corresponding to full capacity utilization (Y_K) depends on the capital stock (K) and the capital-output ratio (v). Note that the capital-output ratio is exogenous and assumed to be fixed in time since there is no substitution between labor and capital in production and we are not coping with technical progress. Thus, we can describe the potential output with equation 4.1.

$$Y_{Kt} = \left(\frac{1}{v}\right) Kt \qquad [4.1]$$

Since v is constant, the growth rate of full capacity output coincides with the rate of capital accumulation (*i.e.,* the growth rate of the capital stock), which we denote as g_K. In each period, capital stock changes increasingly with investment, while part of it depreciates. For this reason, we can express the rate of accumulation as in equation 4.2. Note that δ stands for the rate of depreciation of the capital stock, which is assumed fixed for simplicity.

$$g_{Kt} := \frac{\dot{K}_t}{K_t} = \frac{I_t}{K_t} - \delta \qquad [4.2]$$

With few operations we can obtain equation 4.3.[4] Note that h stands for the investment share in aggregate output, corresponding to the ratio between gross investment and the level of output (Freitas and Serrano, 2015). Hereafter, we may also refer to this variable as the propensity to invest.

$$g_{Kt} = \left(\frac{h_t}{v}\right) u_t - \delta \qquad [4.3]$$

In turn, u_t stands for the degree of productive capacity utilization. It is given by the ratio between current output and full capacity output. The change in capacity utilization ($\hat{u}$) follows the difference between the growth rate of output (g_t) and the growth rate of the capital stock, as in equation 4.4.[5]

$$\dot{u}_t = u_t(g_t - g_{Kt}) \qquad [4.4]$$

We can now determine the level of output for a closed economy without government. In this case, aggregate demand is solely composed of private consumption and private investment. Serrano (1995b) considers that a part of consumption is induced by current income as in the Keynesian multiplier, with a marginal propensity to consume out of income (c) smaller than one. Another part of consumption is autonomous, which means it is neither financed nor directly caused by current income. Within the supermultiplier framework, autonomous demand includes "all those expenditures that are neither financed by the contractual (wage and salary) income generated by production decisions, nor are capable of [directly] affecting the productive

[4] This is done with few manipulations departing from equation 4.2. We start by dividing both elements of the fraction by the variable Y_{Kt}, obtaining:

$$g_{Kt} = \frac{I_t/Y_{K_t}}{K_t/Y_{Kt}} - \delta$$

Then, we can multiply the numerator by the term $\frac{Y_t}{Y_t}$ without changing its value. Rearranging, we obtain:

$$g_{Kt} = \frac{I_t/Y_t.Y_t/Y_{K_t}}{K_t/Y_{Kt}} - \delta$$

Finally, substituting the ratios by the variables defined, we can rewrite the previous expression as in equation 4.3.

[5] The rate of capacity utilization is defined as the ratio between current output and full capacity output: $u_t = Y_t/Y_{Kt}$. By simply taking natural logarithms and derivatives with respect to time in both sides of the previous equation, we obtain the following expression for the rate of change in u_t.

$$\hat{u}_t = g_t - g_{tK}$$

By multiplying both sides by u_t, we can finally obtain the equation 4.4 presented in the text.

capacity of the capitalist sector of the economy" (Serrano, 1995, p. 71). In this simple version, we assume that autonomous consumption can be financed out of accumulated wealth. Thus, we can write equation 4.5 as the equilibrium condition in the market of goods.

$$Y_t = C_{At} + cY_t + I_t \tag{4.5}$$

Investment is assumed to be completely induced in the supermultiplier model once firms adjust the capital stock to demand. We abstract from residential investment and investment in innovation, which are not directly caused by current demand. As described by Serrano and Freitas (2017), the Sraffian supermultiplier assumes that aggregate investment is determined according to the capital-stock adjustment principle. In this view, "inter-capitalist competition influences the process of investment leading to the tendency towards the adjustment of productive capacity to meet demand at a price that covers the production expenses and allows, at least, the obtainment of a minimum required profitability. Thus, the capital stock adjustment principle conceives the demand for capital goods as a derived demand with the objective of creating capacity to meet profitable (or effective) demand". The supermultiplier accounts for this principle by setting investment as induced by current income according to a propensity to invest (h). Thus, by substituting I_t per $h_t Y_t$ in equation 4.5 and rearranging we obtain equation 4.6.

$$Y_t = \left(\frac{1}{1 - c_t - h_t}\right) C_{At} \tag{4.6}$$

The term within parenthesis is the supermultiplier, which corresponds to the magnitude of the indirect impact of autonomous consumption on aggregate income due the recursive effect of income increase on induced consumption and private investment. Freitas and Serrano (2015) emphasize that the level of output is determined by aggregate demand as long as the marginal propensity to spend is smaller than one ($c + h_t < 1$). That has often been labeled as the Keynesian stability condition. We expect this condition to hold in capitalist economies generally.

Otherwise, *i.e.*, if the propensity to spend equals one, then the level of output is not demand constrained, but capacity constrained. To explain this point, let us suppose that the marginal propensity to spend is equal to one ($c + h_t = 1$). In that case, any income increase would immediately cause an increase in demand, which, in turn, would further increase income. This process would be repeated until the economy achieved full capacity. We can see in equation 4.6 that as the marginal propensity to spend approaches one, Y_t, as determined according to autonomous demand and the supermultiplier effect, approaches infinity. If this is the case, there is no lack of aggregate demand. The upper limit to output, given by the availability of productive capacity, is easily reached. In other words, if the marginal propensity to spend is equal to one, the economy follows Say's Law.

Freitas and Serrano (2015) and Serrano and Freitas (2017) show that the investment share must be flexible, allowing capacity utilization to converge towards the normal degree of capacity utilization. On the contrary, if h_t were fixed, changes in the growth rate of capital stock would always lag behind changes in aggregate demand. In this case, the equilibrium rate of capacity utilization would persistently differ from normal capacity. We can better explain this point with a brief example. Assume, for instance, that the growth of autonomous demand accelerates. Then, aggregate demand will grow at a higher rate than before because $g_t = g_{CAt}$ in the long run. In equilibrium, investment grows at the same rate as demand. However, at least for a short period, demand grows faster than the capital stock. The assumption of a fixed h_t implies that the rate of accumulation follows the growth rate of demand without ever exceeding it. Consequently, the rate of capacity utilization remains permanently above the normal capacity utilization after an acceleration of the growth of demand. The opposite outcome (*i.e.*, $u^* < u_n$) is obtained in the case of a slow down in the pace of growth of demand (Freitas and Serrano, 2015).

We conclude that convergence towards normal capacity utilization requires that movements in the accumulation rate overreact to changes in the rate of growth of demand. That is possible by means of a flexible h_t. In other words, investment follows a flexible accelerator investment function in which propensity to invest slowly adjusts whenever current capacity utilization differs from normal capacity. It follows that propensity to invest increases in periods of higher growth of demand, and decreases when aggregate demand slows down. In equilibrium, a larger propensity to invest is associated with a higher growth rate. These results are consistent with expected features arising from competition.[6] Firms tend to keep a certain degree of spare capacity to attend unexpected peaks of demand. However, spare capacity must lie within a limit. Otherwise, it generates unnecessary costs for firms. Hence, if capacity utilization is below the normal degree, firms slow down capital accumulation to avoid the costs of spare capacity (Freitas and Serrano, 2015).

This discussion allows us to write down the expression for the adjustment in the investment share as shown in equation 4.7. Here, γ stands for the sensitivity of the investment share to deviations of capacity utilization with respect to normal capacity, being larger than zero and lower than one. In turn, u_n represents the normal degree of capacity utilization.

[6] Moreover, Girardi and Pariboni (2020) provide empirical evidence supporting the conclusion that the investment share correlates with the rate of growth of autonomous expenditures.

$$\dot{h}_t = h_t \gamma (u_t - u_n) \qquad [4.7]$$

From equations 4.6 and 4.7, we can obtain the expression for the growth rate of output presented in equation 4.8 [7]. Note that g_t stands for the growth rate of output, and g_{CAt} stands for the growth rate of the autonomous consumption.

$$g_t = \frac{h_t \gamma (u_t - u_n)}{1 - c_t - h_t} + g_{CAt} \qquad [4.8]$$

Equation 4.8 shows that output growth is determined by the growth of autonomous consumption plus the change in the propensity to invest when utilized capacity differs from normal capacity. As the rate of capacity utilization converges towards the normal rate, the propensity to invest stabilizes. When this happens, output growth is solely determined by the growth of autonomous consumption.

Now, taking equation 4.4, and substituting in equations 4.3 and 4.8, we obtain:

$$\dot{u}_t = u_t \left[g_{CAt} + \frac{h_t \gamma (u_t - u_n)}{1 - c_t - h_t} - \left(\frac{h_t}{v} \right) u_t + \delta \right] \qquad [4.9]$$

The system formed by equations 4.7 and 4.9 is sufficient for the dynamic analysis of the basic model presented in this section. In equilibrium, $\dot{u}_t = \dot{h}_t = 0$. As a consequence, capacity utilization converges to normal capacity. Both the output growth rate and the accumulation rate converge to the growth rate of autonomous demand (Freitas and Serrano, 2015; Serrano, 1995b). Putting it differently, in equilibrium, $g_t^* = g_{Kt}^* = g_{CAt}^*$. As stressed by Freitas and Serrano (2015), the conclusion that the growth of demand determines the growth of output and capital stock is in line with demand-led growth theory. Plugging the equilibrium values in equation 4.3 gives us the equilibrium investment share, shown in equation 4.10. The equilibrium propensity to invest is a positive function of the rate of growth of autonomous demand.

[7] The equation is obtained from equations 4.6 and 4.7. By taking natural logarithm of equation 4.6, we obtain:

$$lnY_t = ln(1) - ln(1 - c_t - h_t) + ln(C_{At})$$

Then, by canceling the term $ln(1)$ and after taking derivatives with respect to time on both sides, we obtain the expression below.

$$g_t = \frac{\dot{h}_t}{1 - c_t - h_t} + g_{CAt}$$

Finally, we substitute the value for $\dot{h}_t$, as given by equation 4.7, and then we obtain equation 4.8.

$$h_t^* = \frac{v}{u_n}(g_{CAt} + \delta) \qquad [4.10]$$

Freitas and Serrano (2015) show the model to be stable, as long as the "expanded" marginal propensity to spend is smaller than one. Stated differently, stability requires that $c + v + \frac{v}{u_n}(g_{CAt} + \delta) + \gamma v < 1$. This expression represents the marginal propensity to spend added of the term related to changes in the propensity to investment out of equilibrium. If propensity to invest's reaction to deviations of capacity utilization from normal capacity (given by γ) is sufficiently small, then the model is stable.

4.3 The Sraffian supermultiplier in an open economy with government

In this section, we extend the Sraffian supermultiplier to analyze an open economy with government. In this case, we introduce two autonomous expenditures: exports and public expenditure. Both expenditures are autonomous once they are neither financed out of current income nor caused by production decisions. Indeed, exports do not depend on domestic demand but rather on foreign demand. In turn, government counts with several degrees of freedom to run deficits and expand (or compress) public expenditures independently of current income and taxation. That is particularly true for countries whose public debt is invoiced in their sovereign currency (Cesaratto, 2016; Wray, 2015). Introducing foreign trade and government expenditures implies that we must also deal with taxation and propensity to import. For simplicity, we restraint the analysis to the case of two autonomous expenditures, abstracting from autonomous consumption. Hence, hereafter, consumption is assumed to be fully induced by disposable income.

Let us start deriving the equilibrium condition for the goods market. We keep notation whenever possible, identifying only the new variables.

$$Y_t = C_t + I_t + G_t + X_t - M_t \qquad [4.11]$$

Here, G stands for public expenditure; X, exports and M, imports. We carry on setting consumption as induced by the current level of disposable income, as in equation 4.12. τ denotes the income tax rate. As before, c stands for the marginal propensity to consume from disposable income. Moreover, both c and τ are assumed to be constant in time.

$$C_t = c(1 - \tau)Y_t \qquad [4.12]$$

Along the lines of the capital stock adjustment principle, investment depends on both propensity to invest and current income.

$$I_t = h_t Y_t \qquad [4.13]$$

Imported goods are either inputs to domestic production or part of the induced consumption. For this reason, we assume that imports are proportional to the level of income, with a constant propensity to import (m).

$$M_t = mY_t \tag{4.14}$$

Both autonomous expenditures (G and X) can be grouped in a single term Z, so that $Z_t = G_t + X_t$. In this case, output determination can be written as in equation 4.15. The level of output is determined by total autonomous demand and by the supermultiplier. The value of the supermultiplier is smaller than the one in previous section, given the inclusion of taxation and imports. Increases in taxation reduce disposable income, decreasing the impact of the consumption multiplier on aggregate income. In turn, with the inclusion of foreign trade, part of demand leaks to imported goods, mitigating the impact of autonomous demand on domestic income.

$$Y_t = \left(\frac{1}{1 - c(1-\tau) - h_t + m}\right) Z_t \tag{4.15}$$

The propensity to invest behaves according to the same process described in the previous section. We repeat it in equation 4.16.

$$\dot{h}_t = h_t \gamma (u - u_n) \tag{4.16}$$

Finally, we can determine output growth (g) according to the growth of aggregate demand. We obtain equation 4.17 by taking log and derivatives from equation 4.15, and then substituting equation 4.16.

$$g_t = \frac{h_t \gamma (u_t - u_n)}{1 - c(1-\tau) - h_t + m} + g_{Zt} \tag{4.17}$$

As before, output growth depends on the growth of autonomous demand and changes in the propensity to invest. In the present case, however, autonomous demand is composed of exports and public expenditure. Another difference is that the impact of h is weighted by a supermultiplier that includes taxation and the propensity to import.

If the growth rate of autonomous expenditures (g_Z) remains stable for sufficient time, the degree of capacity utilization converges towards the normal capacity ($u = u_n$). Hence, the investment share stabilizes ($\dot{h} = 0$), and the growth rate of output converges to the growth rate of autonomous expenditures (Freitas and Serrano, 2015; Serrano, 1995a,b) (as in equation 4.18).

$$g = g_Z \qquad [4.18]$$

We can now proceed to the discussion of the growth of autonomous demand. Hereafter, we depart from the baseline supermultiplier model, exploring the results from accounting for autonomous public expenditures and exports. That is part of the novelty proposed in this chapter. g_Z depends on the growth rate of government expenditures and the growth rate of exports. From the definition of Z, we obtain that g_Z is given by the average of the growth rates of exports and public expenditure, weighted by the each expenditure's share on Z. This relation is expressed in equation 4.19.

$$g_Z = \sigma_t g_{Gt} + (1 - \sigma_t) g_{Xt} \qquad [4.19]$$

Where,

$$\sigma_t = \frac{G_t}{Z_t} \qquad [4.20]$$

Note that the ratio between government expenditure and total autonomous expenditure (σ_t) varies in time. Departing from equation 4.20, we can take logs and derivative with respect to time, obtaining equation 4.21. Finally, by substituting the definition for g_{Zt} given in equation 4.19, we can define the rate of change of σ as follows in equation 4.22 below. The equation shows that σ changes whenever the rate of growth of exports and public expenditure differ.

$$\dot{\sigma}_t = \sigma_t (g_{Gt} - g_{Zt}) \qquad [4.21]$$

Thus,

$$\dot{\sigma}_t = \sigma_t (1 - \sigma_t)(g_{Gt} - g_{Xt}) \qquad [4.22]$$

If public expenditure grows faster (slower) than exports, then σ_t continuously rises (falls). We can conceive that one of the expenditures keeps growing faster than the other until σ converges to one of the extreme positions — that is, either $\sigma = 0$ or $\sigma = 1$. In this case, one of the autonomous expenditures dominates the explanation of the growth of autonomous demand. However, as modern economies usually count with positive demand from both exports and public expenditures, we argue that this condition does not usually hold.

The fully adjusted position of the supermultiplier model is only obtained under a persistently stable growth rate of autonomous expenditures (Freitas and Serrano, 2015). In the model presented in last section, steady-state was achieved when the autonomous consumption kept persistently growing at a constant rate. However, when we model two autonomous expenditures, the fully adjusted position requires that both expenditures grow persistently at the same rate. Only in this case we have a persistent growth rate for the total autonomous expenditures, in the model with two sources of autonomous demand. That also implies that each autonomous expenditures keeps a constant share in total autonomous demand. Thus, σ is constant in the fully adjusted position.

Appendix A shows that a constant growth rate for the total autonomous expenditures can only be obtained either if both expenditures constantly grow at the same rate or under a very specific growth pattern. In the appendix, we show the second alternative relies on specific assumptions concerning the growth rate of each autonomous component.[8] We abstract from it in the remaining of this chapter.

When modeling growth led by autonomous consumption and autonomous public expenditure, Freitas and Christianes (2020) focus on the steady-state analysis. Therefore, the authors assume each expenditure keeps a stable share in total autonomous expenditures. The level of public expenditure is set as $G_t = \sigma Z_t$, with a constant σ. Likewise, the level of autonomous consumption is defined as $C_{at} = (1 - \sigma)Z_t$. As a consequence, public expenditure growth rate and autonomous consumption growth rate are always equal in this analysis.

In this chapter, we will assume both public expenditures and exports grow at the same rate when the objective is to analyze the steady-state of this growth model. That is done in section 4.3.1, and in section 4.4.3. Nevertheless, we also allow for different growth rates and changes in the share of each expenditure in autonomous demand. Section 4.7 presents the simulation of different experiments, exploring the dynamics out of the fully adjusted position. We show in sections 4.5 and in section 4.7 that the share of each expenditure on autonomous demand matters for the equilibrium value of both public and external debt ratios. Managing the share of public expenditure in autonomous demand is a way fiscal policy can bring the equilibrium foreign debt-to-exports ratio towards the limit acceptable by the international financial market.

The first step, however, is to analyze the equilibrium of the model. We do that in the next section.

[8] As shown in Appendix A, autonomous expenditures must grow at time-varying rates, and one of the expenditures must exactly compensate from movements in the other and from changes in σ to keep a constant value for g_Z. This possibility is disregarded in this chapter since it requires an arbitrary growth pattern for each autonomous expenditure.

4.3.1 Fully adjusted position

We can describe the dynamics of the model with the equations below.

$$\dot{u}_t = u_t \left[\sigma_t g_{Gt} + (1-\sigma_t) g_{Xt} + \frac{h_t \gamma (u_t - u_n)}{1 - c(1-\tau) - h_t + m} - \left(\frac{h_t}{v} \right) u_t + \delta \right] \quad [4.23]$$

$$\dot{h}_t = h_t \gamma (u_t - u_n) \quad [4.24]$$

$$\dot{\sigma}_t = \sigma_t (1 - \sigma_t)(g_{Gt} - g_{Xt}) \quad [4.25]$$

The model achieves the fully adjusted position when $\dot{h}_t = \dot{u}_t = \dot{\sigma}_t = 0$. Hence, we are adding one condition to the basic model presented in section 4.2.1.

According to the previous discussion, it follows that the condition $\dot{\sigma}_t = 0$ gives us $g_Z^{**} = g_{Gt} = g_{Xt}$ (as in equation 4.25). Note that the equilibrium level of σ_t is not relevant. In this case, g_Z is sufficiently persistent to lead the propensity to invest towards equilibrium. Thus, as shown in 4.24, $u^{**} = u_n$. Finally, equation 4.23 gives us an expression for the equilibrium propensity to invest similar to the one presented in section 4.2.1: $h^{**} = \frac{v}{u_n}(g_Z + \delta)$.

4.3.2 Stability analysis

The equilibrium of the system described by equations 4.23, 4.24, and 4.25 is locally stable under the same conditions as the supermultiplier model. The model is therefore locally stable when the expanded marginal propensity to spend (that is, the propensity to spend added of the term γv associated to the accelerator investment function) is smaller than one (Freitas and Serrano, 2015). The condition is expressed as follows:

$$\gamma v + c(1-\tau) + \frac{v}{u_n}(g_Z + \delta) - m < 1 \quad [4.26]$$

We conclude that the simple inclusion of another autonomous expenditure does not affect the local stability of the supermultiplier growth model. The complete stability analysis can be found in the appendix.

4.4 Public Expenditure, Exports and Debt stability

The original supermultiplier model introduced autonomous demand in the form of autonomous consumption, which corresponds to the consumption of capitalists. Another strand of the literature on demand-led growth highlighted exports as a source of autonomous demand. This view acknowledges the twofold role of exports in economic growth. On the one hand, exports constitute part of aggregate demand, affecting output and employment, and growth. On the other hand, exports provide foreign currency, loosening the external constraint and allowing the country to pay for the import of the inputs and capital goods required to economic growth (Kaldor, 1966). Based on this premise, the theory balance of payments constraint growth was developed by Thirlwall (1979).[9] Thirlwall (1979) argues that the balance of payments represents the dominant constraint to demand expansion in open economies. In this view, demand and income changes bring the balance of payments into equilibrium rather than changes in exchange rates or relative prices (Thirlwall, 2012). Thirlwall expressed his preference for the parsimonious model that builds on long-run balanced trade assumption. That implies, though, assuming that trade flows dominate the explanation of the Balance of Payments in the long run.[10]

Along these lines, Thirlwall (1979) introduces a balanced trade account condition, meaning that nominal exports must be equal to nominal imports, as a long-run constraint to demand-led growth. From this condition, the author derives the result known as Thirlwall's Law. Abstracting from changes in the terms of trade, the growth rate compatible with balanced trade is given by the growth rate of exports divided by import's income-elasticity. This result is obtained in few steps. First, balanced trade implies a long-run equality between imports and exports. Assuming a two-good economy, being one imported and the other domestically produced and exported, we can express a balanced trade account as in the following equation:

$$ep_M^* M_t = p_X X_t.$$

p_M^* stands for the international price of the imported commodity, e is the exchange rate expressed as units of domestic currency per unit of foreign currency, and p_X corresponds to the price of the exported commodity in domestic currency. Then, we can define both imports and exports as demand functions, specified as multiplicative with constant elasticities. Therefore, quantities exported or imported vary according to the

9 See Thirlwall (2012) for a historical overview of this approach.

10 However, this is often not the case. Ocampo (2016) argues that the Balance of Payments of emerging markets are dominated by liquidity cycles of international financial markets. In this regard, de Medeiros (2020) posits that: "[t]he history of BoP crises in developing countries since the nineteenth century shows that overborrowing and overlending by bankers have played an autonomous role in the rapid deterioration of external solvency".

income (domestic income affects the demand for imports, and foreign income affects exports), prices, and both income and price-elasticity of demand (Thirlwall, 1979).

$$X = \alpha \left(\frac{p_X}{e p_M} \right)^{\eta} (Y^*)^{\epsilon}$$

$$M = \beta \left(\frac{e p_M}{p_X} \right)^{\psi} (Y)^{\pi}$$

Taking natural logarithms of the last two equations and then differentiating with respect to time, and, finally, substituting in the balanced trade condition gives us the growth rate compatible with the external constraint (denoted as g_b).[11] Hats denote the rate of change in variables.

$$g_b = \frac{(1 + \eta + \psi)(\hat{p}_X - \hat{p}_M - \hat{e}) + \epsilon g^*}{\pi}$$

Finally, abstracting from changes in relative prices gives us the following expression, known as Thirlwall's Law:

$$g_b = \frac{\epsilon g^*}{\pi} = \frac{g_X}{\pi} \qquad [4.27]$$

Therefore, under constant terms of trade, the growth rate compatible with balanced trade is given by the growth rate of exports divided by the income elasticity of demand for imports. Thirlwall (1979) labels this as the balance-of-payments constrained growth rate. The original model does not account for the role of income and capital flows in determining the balance of payments result. For this reason, Thirlwall and Hussain (1982) introduce capital flows in the balance of payments constraint growth model. They argue that countries with positive net capital inflows can finance trade deficits in the initial period. However, only increasing capital flows would allow for the persistence of trade deficit in a growing economy. If capital flows remain constant, the growth rate consistent with balance-of-payments equilibrium will be lower than the original Thirlwall's Law (Thirlwall and Hussain, 1982, p. 502-4). However, rather than considering the absolute level of capital flows, Moreno-Brid (1998) suggests considering the ratio between capital flows and domestic income. Hence, Moreno-Brid (1998) finds the growth rate compatible with a constant ratio between the trade deficit and income.

[11] Taking natural logarithm and derivatives with respect to time of the three equations gives us:

$$\hat{e} + \hat{p}^*_M + g_M = \hat{p_X} + g_X$$

$$g_X = \eta(\hat{p}_X - \hat{p}^*_M - \hat{e}) + \epsilon g^*$$

$$g_M = -\psi(\hat{p}_X - \hat{p}^*_M - \hat{e}) + \pi g$$

By substituting the last two equations in the first one, we can obtain the expression in the text.

This model shows that capital flows can finance trade account deficits in non-explosive dynamics, keeping a stable ratio between capital inflows and income. Growth is still constrained by the balance of payments but under different conditions (Moreno-Brid, 1998). Building on this framework, Moreno-Brid (2003) further develops this model, including net interest payments. Finally, Caldentey and Moreno-Brid (2019) reexamine both Thirlwall (1979) and Moreno-Brid (1998) contributions, emphasizing the effect of long-run trends in terms of trade. Indeed, the previous models abstracted from the impact of changes in the terms of trade in either tightening or loosening the external constraint. Nevertheless, Caldentey and Moreno-Brid (2019, p. 464) argue that the "inclusion of the terms of trade (if they are significant) implies that the rates of growth compatible with balance-of-payments equilibrium should be calculated on the basis of income rather than gross domestic product (GDP). The inclusion of capital flows implies that the basic balance rather the current account is the correct measure of a country's external position."

Departing from the previous contributions, Barbosa-Filho (2001) suggests framing the balance of payments constraint in terms of long-run sustainability of external debt rather than in a constant deficit or balanced trade condition. The accumulation of foreign liabilities leads to a convergent and stable external debt-to-income ratio whenever the income growth rate is larger than the interest rate on debt service.[12] Building on this approach, Bhering et al. (2019) point out that the foreign debt should be compared to the level of exports rather than domestic income. The authors emphasize the currency mismatch between domestic income and foreign debt, stressing that the value of exports consists of a proper measure of solvency of a country for liabilities taken in foreign currency. Thus, the authors follow Barbosa-Filho (2001), assessing the long-run convergence of external debt. However, they normalize debt and balance of payments variables by exports rather than domestic output.

Models following Thirlwall's tradition usually assume that exports are the only source of autonomous demand in the long run.[13] As pointed by Bhering et al. (2019), the

[12] Thus, given the initial values of exports and imports, "it is straightforward that d [that is, the foreign debt-to-income ratio,] is stable as long as the home growth rate exceeds the real cost of foreign debt in home currency" (Barbosa-Filho, 2001, p. 396).

[13] Thirlwall (1997, p. 378) claims Balance-of-Payments constrained growth model build on the same assumptions as Harrod's foreign trade multiplier, "namely, that exports are the only component of autonomous demand, that trade is balanced, and the terms of trade remain unchanged". McCombie (1985) introduces other source of autonomous expenditures, though he posits that it must adjust to the growth of exports in the long run. The assumption that exports are the only autonomous expenditure is often associated with Kaldor's remarks on growth. According to the author, "[f]rom the point of view of any particular region, the 'autonomous component of demand' is the demand emanating from outside the region; and the Hicks' notion of the 'super-multiplier' can be applied so as to express the doctrine of the foreign trade multiplier in a dynamic setting. So expressed, the doctrine asserts that the rate of economic development of a region is fundamentally governed by the rate of growth of its exports. For the exports, via the 'accelerator'; will govern the rate of growth of industrial capacity, as well as the growth of consumption; it will also serve to adjust (again under rather severe simplifying assumptions) both the level, and the rate

conclusion that growth is always constrained by the Balance of Payments depends on this assumption. Introducing another source of autonomous demand means that the external constraint may not be binding. Growth is also affected by the growth rate of the other autonomous expenditure. Hence, if the other autonomous expenditure grows at a pace slower than exports, the economy (and, thus, imports) grows less than exports, obtaining trade surpluses.

Within the supermultiplier literature, exports have been less explored in comparison with other autonomous expenditures. Dejuán (2017) includes exports as the only autonomous expenditure in an open economy version of the supermultiplier model. However, the author focuses on the stability of growth in models with an accelerator investment function. Nah and Lavoie (2017) include exports in a supermultiplier model, further assuming that exports growth rate is given by an exogenous trend plus a negative effect of the wage share. The authors focus on the relation between growth and distribution in the 'traverse' to the fully adjusted position. Finally, exploring different sources of autonomous demand, Dutt (2019) briefly discusses the case of a supermultiplier model with exports as the only autonomous expenditure.

Unlike the mentioned contributions, in this chapter, we account for exports and public expenditure as sources of autonomous demand. We discuss how the model presented in this chapter relates with the Balance of Payments constraint to economic growth. We also define conditions for the long run stability of both public and external debt ratios. Convergence of debt ratios to stable values supports the feasibility of growth being led by public expenditure and exports in the long run.

The Sraffian supermultiplier as proposed by Serrano (1995a) relied on autonomous consumption as the source of autonomous demand in a closed economy without government. Serrano (1995a,b) assumed autonomous consumption to be financed out of accumulated wealth. We may also conceived it as financed out of credit.[14] In any case, the long-term sustainability of the autonomous expenditure must be evaluated, ensuring a stable stock of wealth or a sustainable level of debt are consistent with the growth of the autonomous expenditure in the long term.[15] Along these lines, Pariboni (2016b) assessed the sustainability of private debt in a supermultiplier model led by consumer credit. The author also showed that problems to the long-run sustainability of private debt arise when another autonomous expenditure is introduced in the analysis. Thus, if debt-financed consumption grows faster than the other component of autonomous demand, "the accumulation of debt is faster than the growth of the whole

of growth, of imports to that of exports" (Kaldor, 1978, p. 146). See Palumbo (2009) for an interpretation of Kaldor's ideas on foreign trade and growth.

14 See Cesaratto (2017).

15 Recently, Hein and Woodgate (2020) raised this point. They claim that financial stocks (as wealth and debt) should be deeply analyzed in growth models following the supermultiplier framework since the long-run stability of growth depends on these stocks.

autonomous part of demand, which determines the rate of growth of output" (Pariboni, 2016b, p. 227). Therefore, when more than one autonomous expenditure is considered, the long run stability of debt also depends on the other autonomous components' growth rate. We will show in the next pages that this is also the case in an integrated analysis of public and foreign debt sustainability.

The stability of public debt has long been a concern in theoretical debates, particularly in approaches compatible with demand-led growth perspective (Domar, 1944). Public debt dynamics has been analyzed in terms of the ratio between public debt and aggregate income, what we label as the public debt-to-income ratio. Domar (1944) concluded *inter alia* that the public debt-to-income ratio converges to an equilibrium level in the long run as long as the growth rate is larger than the interest rate. Hereafter, we refer to this result as the Domar stability condition. For this reason, Domar (1944) suggests conceiving the issue of public debt as a matter of economic growth.[16]

In light of the supermultiplier growth model, we can account for public expenditure as a relevant component of autonomous demand. Indeed, countries with monetary sovereignty can finance deficits with taxes, debt issue, and monetary emission.[17] Being rather independent of taxation, public expenditure growth can be considered exogenous to current income and firm's production decisions, thereby being an autonomous expenditure. Allain (2015) modeled public expenditure as an autonomous expenditure, showing that public expenditure may act as a stabilizer of economic growth in the supermultiplier model.[18] However, the author does not account for the public deficit and public debt, since he assumes the public budget is kept balanced by tax rate adjustments. Cassetti et al. (2017) simulates a supermultiplier model with public expenditure as the only source of autonomous demand. The author discusses the interaction of growth with inflation, distribution, and public debt. In turn, Hein (2018) introduces public expenditure, debt dynamics, and the related distributive concerns in a Kaleckain version of the supermultiplier model. The analysis considers only one autonomous expenditure in a closed economy setting. Hein (2018) concludes that primary public deficit (or surplus) and public debt converge to stable values as long as the growth rate of public expenditure is larger than the interest rate on debt service and that the supermultiplier's stability condition holds.

16 Indeed, as stated by the author, "the problem of the debt burden [that is, the problem of the magnitude of primary budget surplus required to pay for debt service,] is essentially a problem of achieving a growing national income" (Domar, 1944, p. 822).

17 See, for instance, Wray (2015) and Cesaratto (2016) for descriptions of the circuit of expenditures decisions and government finance in economies with monetary sovereignty.

18 Allain (2015) points out that autonomous demand had not been properly accounted for in Kaleckian growth literature yet, even in the case of expenditures that may be typically considered autonomous as public expenditure and exports. In this literature, "government expenditure or public deficits are assumed to be proportional to capital stock and then to grow at the same rate. When exports are introduced, they are partly autonomous, but the results of the models do not fully take into account the consequences of this exogeneity" (Allain, 2015, p. 5-6).

These three contributions consider government expenditure as the only source of autonomous demand, avoiding the complications arising from the inclusion of more than one autonomous expenditure. However, such a shortcoming was addressed by Freitas and Christianes (2020), and Hein and Woodgate (2020), who include autonomous private consumption in the analysis. Freitas and Christianes (2020) restrain their analysis to the steady-state. They show that, assuming Domar stability condition holds, the growth rate of autonomous demand and the composition of autonomous demand (that is, the share of each expenditure) affect the equilibrium level of public debt-to-income ratio and the equilibrium primary deficit-to-income ratio. In this model, an increase in the equilibrium growth rate of autonomous demand reduces the equilibrium public debt-to-income ratio. In contrast, an increase in the government share in autonomous demand increases the equilibrium public debt-to-income ratio. Freitas and Christianes (2020) also discuss the relation between the level of debt and the impact of interest rate and taxation on distribution, showing that changes in distribution have a feedback effect on the level of output (but not in its equilibrium growth rate).[19] In turn, Hein and Woodgate (2020) also account for both autonomous consumption and government expenditure in a supermultiplier model framed within the Kaleckian perspective. The authors focus on the relation between the consumption out of the financial income of public debt creditors and Harrodian instability.

What happens when we combine exports and public expenditures as sources of autonomous demand? In the next sections, we discuss how introducing public expenditure affects the external constraint given by the stability of foreign debt. Thus, we carry on in the analysis of a supermultiplier model with exports and public expenditure as components of autonomous demand, as presented in section 4.3. In the next section, we approach public and foreign debt dynamics in this approach.

4.4.1 Public debt

Let us start considering the case of public debt. The main reference consistent with the model presented here is Freitas and Christianes (2020). As discussed above, Freitas and Christianes (2020) develop a supermultiplier model with autonomous private consumption and autonomous public expenditure, presenting conditions for public debt stability. Differently from these authors, we initially allow for the share of each autonomous expenditure (in total autonomous demand) to change in time. Changes in these shares also occur in the simulations presented in section 4.7.

The change in total public debt, denoted by $\dot{B}$, is described in equation 4.28. The change in the public debt depends on the government expenditure (G_t), the total amount

[19] This result is consistent with previous conclusions of the supermultiplier growth model (Freitas and Serrano, 2015).

of taxes — given by a proportional tax rate (τ) times current income level (Y_t) — and the total debt service — depending on the interest rate (i) and the total debt (B_t).

$$\dot{B}_t = G_t - \tau Y_t + iB_t \qquad [4.28]$$

The relevant economic variable for the analysis of public debt is the ratio between debt and income. We can denote it as b, as defined below.

$$b_t = \frac{B_t}{Y_t} \qquad [4.29]$$

From this definition, we can deduce the rate of change in the debt-income ratio as follows:

$$\dot{b}_t = \frac{\dot{B}Y - B\dot{Y}}{Y^2} = \frac{\dot{B}_t}{Y} - \frac{\dot{Y}_t}{Y}b \qquad [4.30]$$

Then, we can substitute 4.28 in 4.30, obtaining equation 4.31.

$$\dot{b}_t = \frac{G_t}{Y_t} - \frac{\tau Y_t}{Y_t} + \frac{iB_t}{Y_t} - g_t b_t \qquad [4.31]$$

By further simplifying, we get the expression below.

$$\dot{b}_t = \sigma_t z_t - \tau + ib - g_t b_t \qquad [4.32]$$

Remember that σ_t stands for the share of government expenditure in total autonomous expenditures. In turn, z_t stands for the ratio of autonomous expenditures to total output. As shown by Freitas and Christianes (2020), the term $\sigma_t z_t - \tau$ corresponds to the primary government deficit (or surplus) to output ratio.

4.4.2 Foreign debt

We introduce the analysis of foreign debt's long-run stability, following Barbosa-Filho (2001). We accept the suggestion of Bhering et al. (2019) to focus on the debt-to-exports ratio, acknowledging the existence of a currency mismatch between foreign liabilities and domestic income. We assume the Balance of Payments is composed of the trade balance, factor income balance and capital account. We also assume the factor income balance is solely composed of external debt service payments. Thus, trade balance plus external debt service constitute the current account. Note that while Bhering et al. (2019) develop their model in discrete time, we express the same relations in continuous time. Still following Bhering et al. (2019), we assume that capital flows (denoted by F) are just enough to cover the deficit in the current account. Hence, the result of the Balance of Payments is equal to zero so that the country neither accumulates nor looses reserves. This assumption is related to the analytical purposes of the model and does not posit any automatic adjustment of the Balance of Payments as a feature of real economies.

Then, if capital flows are equal to the current account deficit, we can write equation 4.33.

$$F_t = M_t - X_t + R_t \tag{4.33}$$

As usual, M and X stand for imports and exports. In its turn, R represents the external debt service payments. Hence, it is proportional to the international interest rate (r) and the total debt (D). For simplicity, we assume r to be fixed in time.

$$R_t = rD_t \tag{4.34}$$

The change in external debt will be given by the net entrance of capitals to finance the current account deficit. Thus,

$$\dot{D}_t = F_t \tag{4.35}$$

Finally, gathering the previous relations in equations 4.33, 4.34, 4.35, we get:

$$\dot{D}_t = M_t - X_t + rD_t \tag{4.36}$$

Following Bhering et al. (2019), we study the dynamics of the ratio between external debt and exports. The underlying reasoning is related to the solvency conditions of a country in terms of foreign currency. For this reason, Bhering et al. (2019) reject analyses centered in the external debt-to-output ratio (as done by Moreno-Brid, 1998; and Barbosa-Filho, 2001), defining exports as the relevant variable to explain the long-term solvency of the external debt. Thus, we can define:

$$d_t = \frac{D_t}{X_t} \tag{4.37}$$

Its derivative with respect to time is given by.

$$\dot{d}_t = \frac{\dot{D}_t X_t - D_t \dot{X}_t}{X_t^2} \tag{4.38}$$

We can rewrite as:

$$\dot{d}_t = \frac{\dot{D}_t}{X_t} - \frac{\dot{X}_t}{X_t}\frac{D_t}{X_t} \tag{4.39}$$

Let us set that $\frac{\dot{X}_t}{X_t} = g_{Xt}$, where g_{Xt} is the growth rate of exports, assumed to be constant in time. By substituting the result for $\dot{D}_t$ of equation 4.36, we obtain the expression below.

$$\dot{d}_t = \frac{M_t - X_t + rD_t}{X_t} - g_{Xt} d_t \tag{4.40}$$

Thus, with simple manipulations we can write:

$$\dot{d}_t = \frac{M_t}{X_t} - 1 + r d_t - g_{Xt} d_t \tag{4.41}$$

Finally, we obtain the expression 4.42.

$$\dot{d}_t = \frac{M_t}{X_t} - 1 + (r - g_{Xt}) d_t \tag{4.42}$$

As pointed by Bhering et al. (2019), the equation shows that $r < g_X$ is a necessary condition for the stability of the ratio of the external debt-to-exports. That implies that exports must raise at a higher rate than the debt service — and it is analogous to the condition pointed in the case of the public debt. In other words, for debt to be sustainable, the growth of debt due to debt service must be slower than exports growth. Otherwise, the rise in debt caused by interests is enough to generate a path of increasing external indebtedness.

Still, we can rewrite expression 4.42 as follows in equation 4.43. In this result, it becomes evident that then the path of foreign debt-to-exports ratio diverges if σ_t approaches 1.

$$\dot{d}_t = \frac{m}{(1-\sigma_t)z_t} - 1 + (r - g_{Xt})d_t \qquad [4.43]$$

4.4.3 Fully adjusted position and debt stability

We can summarize the system in five equations, which are presented below. Note that the first three come from the supermultiplier growth model, considering the presence of the two autonomous expenditures. The last two are related to public and external debt.

$$\dot{u}_t = u_t \left[\sigma_t g_{Gt} + (1-\sigma_t)g_{Xt} + \frac{h_t\gamma(u_t - u_n)}{1 - c(1-\tau) - h_t + m} - \left(\frac{h_t}{v}\right)u_t + \delta\right] \qquad [4.44]$$

$$\dot{h}_t = h_t\gamma(u_t - u_n) \qquad [4.45]$$

$$\dot{\sigma}_t = \sigma_t(1-\sigma_t)(g_{Gt} - g_{Xt}) \qquad [4.46]$$

$$\dot{b}_t = \sigma_t z_t - \tau + ib - g_t b_t \qquad [4.47]$$

$$\dot{d}_t = \frac{m}{(1-\sigma_t)z_t} - 1 + (r - g_{Xt})d_t \qquad [4.48]$$

Equation 4.46 shows that stability of σ imposes that $g_X = g_G$. As pointed in section 4.3.1, the fully adjusted position requires that both autonomous expenditures grow at the same rate ($g_X = g_G$). Otherwise, the total autonomous expenditures (Z) cannot grow at a stable rate, which would prevent a formal description of the equilibrium. When both autonomous expenditures grow at the same rate, σ achieves a constant value. In this case, $\dot{\sigma}_t = 0$, as can be seen in equation 4.46. Note also that this can happen at any level of σ. We denote this constant value for σ as σ^*, even though it does not correspond to a specific value. Given this condition, a constant σ allows for a persistently stable growth rate of autonomous demand (g_Z). In that case, the economy converges to the fully adjusted position, as in the baseline supermultiplier model. In this equilibrium, the growth rate converges to the growth rate of autonomous demand, propensity to invest stabilizes, and capacity utilization converges to normal capacity. The equilibrium positions for output growth, propensity to invest and capacity utilization were presented in section 4.3.1. In this section we discuss the equilibrium levels for public debt-to-income ratio and foreign debt-to-exports ratio.

By setting equation 4.47 equal to zero, we obtain the equilibrium level of the public debt-to-income ratio. The equilibrium for this ratio is expressed in the equation below.

$$b^* = \frac{\sigma^* z^* - \tau}{g_Z - i} \qquad [4.49]$$

Note that the value for z^* emerges from the system of equations describing the supermultiplier growth model. z^* is given by the inverse of the equilibrium value of the supermultiplier, as shown in the equation below.

$$z^* = 1 - c(1-\tau) - (g_Z + \delta)\frac{v}{u_n} + m \qquad [4.50]$$

Public debt-to-income ratio converges to a positive value if the public budget is in deficit in the fully adjusted position, that is, if $\sigma^* z^* > \tau$. The equilibrium level of public debt-to-income ratio is larger when the share of government expenditure in autonomous demand is larger. The condition that the equilibrium growth rate, given by the growth of autonomous demand, is larger than the interest rate is fundamental for the long-term stability of the public debt-to-income ratio. This result was recalled by Freitas and Christianes (2020), being considered a version of Domar‘s stability condition (Domar, 1944). Moreover, note that public debt stability does not depend on the value of σ^*. That is true even in the extreme case in which government expenditure dominates autonomous demand, and σ^* is equal to 1. In contrast, if exports fully explain autonomous demand with σ^* equal to 0, the public debt-to-income ratio converges to a negative stable value.

Let us now consider the case of foreign debt. By setting equation 4.48 equal to zero, we can obtain the equilibrium level for the foreign debt-to-exports ratio, expressed in equation 4.51. Note that for simplicity, g_X was substituted per g_Z, since the equilibrium requires that both variables have the same value.

$$d^* = \left[\frac{m}{(1-\sigma^*)z^*} - 1\right]\left(\frac{1}{g_Z - r}\right) \qquad [4.51]$$

Equation 4.51 shows that the country will accumulate debt if, in equilibrium, the term within brackets is positive. This occurs when the country faces persisting trade deficits. given the propensity to import and the share of exports in output. Otherwise, if the country faces a trade surplus in the equilibrium, it will accumulate foreign credit rather than external debt.

The condition that the growth rate of exports is larger than the interest rate on foreign debt is fundamental for the stability of d. If this condition does not hold, then the growth of exports is not enough to offset the increase in the foreign debt caused by the debt service, leading to an increasing foreign debt-to-exports ratio. Moreover, equation 4.51 shows that if the ratio between government expenditure and income is equal to one (*i.e.*, $\sigma^* = 1$), debt-to-exports ratio diverges. In the steady-state derived from this condition, government expenditure dominates the determination of autonomous demand growth. As a consequence of domestic income growth, the economy accumulate trade deficits, since it imports goods and services but it does not export. Hence, an increasing amount of foreign debt is accumulated in each period.

4.4.4 Sensitivity analysis

We performed a sensitivity analysis to test the robustness of the complete model, inclusing the supermultiplier model and the dynamics of the public and external debt ratios — *i.e.*, the dynamic system formed by equations 4.23, 4.24, 4.25, 4.47, and 4.48. The sensitivity analysis shows that the model is robust to shocks in its main parameters, provided that the growth rates of public expenditure and exports do not remain persistently different.

We performed a sensitivity analysis through Monte Carlo experiments of random shocks in the growth rate of government and exports, domestic and international interest rates, propensity to import, tax rate, and the sensitivity of propensity to invest to deviations of capacity utilization. Detailed results are reported in the appendix.

Convergence to steady-state of capacity utilization, propensity to invest, government's share on autonomous demand (σ), public debt-to-income ratio (b), and external debt-to-exports ratio (d) are robust to shocks in parameters as the interest rate (i), and the international rate (r), propensity to import (m), tax rate (τ), and the sensitivity parameter in the investment function (γ). Nevertheless, the convergence of σ, b, and d depends crucially on the growth rate of each of the autonomous expenditures. Permanent shocks in the growth rate of government expenditure (g_G) and exports (g_X) that keep the two growth rates persistently different from each other lead to divergence in the three variables.

However, when we assume that the shocks affect g_G and g_X in the same way, thereby preserving the equality between the two growth rates, σ, b, and d converge to the equilibrium. Noteworthy, capacity utilization and the propensity to invest converge to the steady-state equilibrium regardless of the equality between the growth rates.

4.5 The external constraint and Thirlwall's Law

Until now, we have assumed that creditors will finance any level of foreign debt. However, let us introduce an upper limit to the debt-to-exports ratio — similarly to what has been done in Bhering et al. (2019). This limit may be due to the imposition of an international institution or a threshold effect considered in international capital markets, meaning that above such limit, capital inflows cease. We denote the bound to foreign debt as $\bar{d}$. Naturally, such a constraint does not raise concerns if it is larger than the equilibrium level of foreign debt. Let us focus, thus, on the case in which $\bar{d} < d^*$.

An exogenous bound to external debt generates policy concerns for the domestic economy. Given this ceiling, the variables that determine the equilibrium external debt-to-exports ratio (that is, the variables in the right-hand side of equation 4.51) must be changed, pushing the equilibrium level of d towards $\bar{d}$. Suppose the current foreign debt-to-exports ratio is sufficiently below $\bar{d}$. In that case, there is room for structural change policies that may affect the composition of output, the propensity to import, and even stimulate export growth as technical progress improves the income elasticity of exports.[20] In terms of the model's parameters, these types of industrial and innovation policies inducing structural change may lead to a lower m, increase the share of exports in output (reducing σ) or even increase the growth of exports (g_X). These changes affect the equilibrium foreign-debt-to exports ratio, contributing to lead it towards the upper limit level. Since these policies take time to affect the parameters, their implementation requires that the economy is still able to maintain increasing indebtedness before their results appear.

In contrast, it may be the case that current indebtedness is too close to $\bar{d}$ or that policymakers reject structural change policies in favor of slowing the pace of economic growth. Section 4.6 develops a fiscal policy rule compatible with the external constraint. Previous discussions on the balance of payments constraint to growth have emphasized that corrections in the balance of payments happen through changes in aggregate income rather than exchange rates or relative prices (Thirlwall, 1979, 2012). Furthermore, Barbosa-Filho (2001) argued that the equilibrium consistent with the Balance of Payments constraint can be achieved by means of demand management, that is, changes in fiscal policy.

Our result also shows how a long-term limit to external finance constrains the growth of public expenditure. This result is in line with Hein and Woodgate (2020), who

[20] Araujo and Lima (2007) shows that structural change affecting the composition of output and exports towards a larger share of industries with a larger demand income-elasticity can loosen the external constraint, increasing the growth rate compatible with the Balance of Payments constraint. Cimoli et al. (2009) argue that some developing economies performed better than others in terms of growth because of structural change in favor of more technological and efficient sectors which allow for a larger output growth within the external constraint.

suggested the assessment of how financial cycles or constraints affect the sustainability of autonomous expenditures. The external constraint consists of a financial constraint to the domestic economy once it relies on imported inputs or final goods that can only be purchased with an internationally accepted currency. In our model, this currency can be obtained either through exports or by accepting foreign liabilities.

Suppose the availability of capital flows depends on the level of debt, or, in particular, on the foreign debt-to-exports ratio. In that case, the possibilities of economic growth are also shaped by this condition. When the foreign debt-to-exports ratio surpasses the acceptable upper level, capital flows cease, interrupting the availability of the imported inputs and final goods required for production and growth to take place.

The next section analytically shows that introducing a limit to the external debt brings back Thirlwall's Law as an upper limit to growth in the long run.

4.5.1 Thirlwall's Law in the supermultiplier

In section 4.4.3, foreign debt-to-exports ratio converges to a stable value under two conditions. First, the growth rate of exports must be larger than the interest rate on foreign debt. Second, the share of public expenditures in autonomous demand must be smaller than one ($\sigma < 1$). However, introducing a limit to foreign debt-to-exports ratio brings back the external constraint to economic growth. Bhering et al. (2019) argue that if there is a ceiling to foreign debt ratio, the growth rate compatible with the external constraint is given by Thirlwall's Law.[21] We explicitly show that this result holds in a supermultiplier model with autonomous public expenditure and exports. Therefore, Thirlwall's Law imposes an upper limit to growth in the long term, although it does not determine output growth rate, which depends on the growth of both components of autonomous demand. We also show that a positive difference between exports growth rate and the international interest rate relaxes the external constraint in the short run. In this case, the economy can grow faster than the rate defined by Thirlwall's Law even if it must keep a constant foreign debt-to-exports ratio.

Let us carry on now on this analysis. We start from the expression for the change in foreign debt-to-exports ratio (equation 4.42). Since we assumed a constant propensity to import m, imports grow at the same rate as output. Then, we can rewrite the current value of imports as the initial value multiplied by the accumulated output growth. The same procedure can be done with exports' initial value and exports growth rate. By these

[21] After exploring the effects of the introduction of a limit in the foreign debt-to-exports ratio, the authors conclude that "in the longer run, the BoP-constrained rate of growth remains the same: Thirlwall's law. A result easily understood once we consider that while the level of imports may be (if b > 0, [where b stands for the ratio between the capacity to import and exports]) permanently higher than exports, those imports cannot grow permanently at a faster rate than exports without making the current account and external debt relative to exports grow without limit. (Bhering et al., 2019, p. 491)"

means, we obtain equation 4.52. The initial values of imports and exports are denoted by the subscript 0.

$$\dot{d}_t = \left(\frac{M_0 e^{\int_0^t g.dt}}{X_0 e^{\int_0^t g_X.dt}} \right) - 1 + (r - g_{Xt}) d_t \qquad [4.52]$$

Suppose we must keep a constant ratio of foreign debt-to-exports. In that case, we set $\dot{d} = 0$. We keep the assumption that $r < g_X$, otherwise d would be inherently unstable. With simple operations in the last equation, after making $\dot{d} = 0$, we can obtain the expression below.

$$e^{\int_0^t g.dt} = e^{\int_0^t g_X.dt} \frac{X_0}{M_0} [1 - (r - g_X) d_t] \qquad [4.53]$$

And then, by taking natural logarithms of both sides, we obtain equation 4.54.

$$\int_0^t g.dt = \int_0^t g_X.dt + \ln\left(\frac{X_0}{M_0}\right) + \ln[1 - (r - g_X) d_t] \qquad [4.54]$$

The integral of the growth rates over the period $[0, t]$ must be equal to the average growth rates in the same period times t. Hence, we can substitute both integrals by its averages as in equation 4.55. The superscript μ denotes the average over the period $[0, t]$.

$$g^\mu t = g_X^\mu.t + \ln\left(\frac{X_0}{M_0}\right) + \ln[1 - (r - g_{Xt}) d_t] \qquad [4.55]$$

In this case, the average output growth rate that is compatible with a constant d is given by the equation 4.56.

$$g^\mu = g_X^\mu + \frac{1}{t}\{\ln\left(\frac{X_0}{M_0}\right) + \ln[1 - (r - g_{Xt}) d_t]\} \qquad [4.56]$$

Therefore, the average growth rate compatible with a constant d is equal to the average growth rate of exports plus a term depending on the initial trade balance and the difference between the international interest rate and the exports growth rate. Suppose the economy presented a trade deficit in period 0 (with $X_0 < M_0$). In that case, the term within braces is positive whenever the condition in inequality 4.57 holds. According to this inequality, average output growth can exceed average growth of exports when the initial trade account deficit normalized by exports is smaller than the effect of exports growth and interest rate on the foreign debt-to-exports ratio.[22]

$$\frac{M_0 - X_0}{X_0} < (g_X - r)d_t \qquad [4.57]$$

The difference between exports growth and the international interest rate has a negative impact on the change in the foreign debt-to-exports ratio. Inequality 4.57 holds if this effect more than compensates the positive impact of the initial trade deficit, relaxing the external constraint. Therefore, according to this condition, domestic expenditures can grow faster than exports without affecting the foreign debt-to-exports ratio. This result provides further degrees of freedom to g_G since the growth of output (g) depends on the growth rate of autonomous demand, which is an weighted average of the growth of the two autonomous expenditures. In this case, if output can grow more than exports, public expenditures are allowed to grow even faster. The smaller the σ, the larger the possible difference between the growth rate of the two autonomous expenditures.

Nevertheless, we can also see in equation 4.56 that the average output growth rate that maintains d constant approaches the average exports growth rate in the long run. As t approaches $+\infty$, g^{μ} converges to g_X^{μ}.

That result is not different from the Thirlwall's Law. According to Thirlwall's Law, balance of payments constrained growth rate is given by the growth rate of exports divided by the income-elasticity of imports (see equation 4.58, discussed in section 4.4). In the present case, the income-elasticity of imports (π) is constant and equal to one since we assume the propensity to import to be constant.[23] In the equation above, that implies that the growth rate of output must be equal to the growth rate of exports.

$$g_b = \frac{g_X}{\pi} \qquad [4.58]$$

[22] Inequality 4.57 is obtained as follows. In equation 4.56, we can see that if the average output growth compatible with a constant d can be larger than exports growth, then the term within braces must be positive. That is,

$$\ln\left(\frac{X_0}{M_0}\right) + \ln[1 - (r - g_{Xt})d_t] > 0$$

Since we are assuming that $X_0 < M_0$, the term $ln(X_0/M_0)$ is negative. In this case, the previous inequality holds if:

$$\ln[1 - (r - g_{Xt})d_t] > -\ln\left(\frac{X_0}{M_0}\right)$$

By operating the exponential function of e in both sides, we obtain the inequality 4.57 shown in the text.

[23] Total imports are given by $M = mY$. Thus, we can calculate the income elasticity of imports as follows:

$$\pi = \frac{dM}{dY}\frac{Y}{M} = \frac{m}{m} = 1$$

Therefore, the introduction of a ceiling for the foreign debt-to-exports ratio brings back the external constraint to economic growth. The growth rate compatible with the external constraint (g_b) represents an upper limit to growth. We showed that this growth rate corresponds to the one given by Thirlwall's Law. As discussed above, for large values of t, g^{μ} gets closer to g_X^{μ}, which, for a constant propensity to import, corresponds to the growth rate known as Thirlwall's Law (Thirlwall, 1979).

Even though it imposes an upper limit to economic growth, the external constraint is not necessarily binding. If public expenditures continuously grow less than exports, the economy does not reach the growth rate given g_b. In that case, the foreign debt-to-exports ratio tends to fall. Therefore, the model presented in this chapter allows for two different growth regimes, exploring two alternative regimes included in demand-led growth. As stated by Freitas and Dweck (2013, p. 168), the supermultiplier "theoretical framework conceives two possible growth regimes: a balance of payments constrained demand-led growth process, and a policy constrained (or pure) demand-led growth process".

4.6 Fiscal Policy and the External Debt

The sustainability of growth in the long term requires the economy to remain within the external debt limit. Assuming a given growth rate of exports means that public expenditure growth must be moderated to avoid that the external debt exceeds the threshold. The external constraint sets a boundary for the growth of domestic autonomous expenditures (in this model, public expenditure). Therefore, fiscal policy management can prevent the convergence of the debt-to-exports ratio towards an excessively high ratio.

Fiscal policy intervention can change the value of σ to keep the economic within the external debt limit. This outcome can be achieved by keeping the growth rate of public expenditure below the growth rate of exports until σ reaches the value of $\bar{\sigma}$ expressed in equation 4.59. $\bar{\sigma}$ corresponds to the ratio between public expenditure and income that is compatible with the upper limit to foreign debt-to-exports ratio, given the growth rate of exports, the propensities to import and to consume, the tax rate, and the international interest rate. Putting it differently, fiscal policy can keep $g_G < g_X$, which leads to a decreasing σ, as shown previously in equation 4.46. This regime must be kept long enough, allowing σ to reach $\bar{\sigma}$. When this happens, the growth rate of public expenditure can return to the steady-state value (equal to g_X). Then, the economy achieves a new steady-state compatible with the constraint to external indebtedness.

$$\bar{\sigma} = 1 - \left(\frac{m}{z^*(1+\bar{d})(g_X - r)} \right) \quad [4.59]$$

We define a rule for fiscal policy according to which the growth rate of public expenditure is compatible with the limit to foreign indebtedness. This rule requires evaluating the necessary change in σ in each period and adjusting the growth rate of public expenditures accordingly. Knowing $\bar{d}$ and g_X allow us to obtain $\bar{\sigma}$ as in equation 4.59. Note that the value of z^* is also known since we are assuming a constant g_X. The export growth rate, in turn, gives us the steady-state value for h, the only time-varying parameter in the determination of z^*. However, defining both σ_t and $\bar{\sigma}$ is not enough to establish the rule for the growth rate of public expenditures. We still need to find the speed of adjustment of σ_t that is compatible with the limit in foreign-debt-to exports ratio. This speed is proportional to the distance between the current foreign-debt-to export ratio and the ratio's upper limit. In other words, the sooner the current path of debt tends to achieve $\bar{d}$, the faster must be the convergence of σ_t towards $\bar{\sigma}$.

Let us further explain this mechanism with a brief example, represented in figure 4.1. Assume that according to current trends, the economy will converge to a steady-state compatible with the limit to the foreign debt-to-export ratio ($\bar{d}_0$). Further, assume that, in

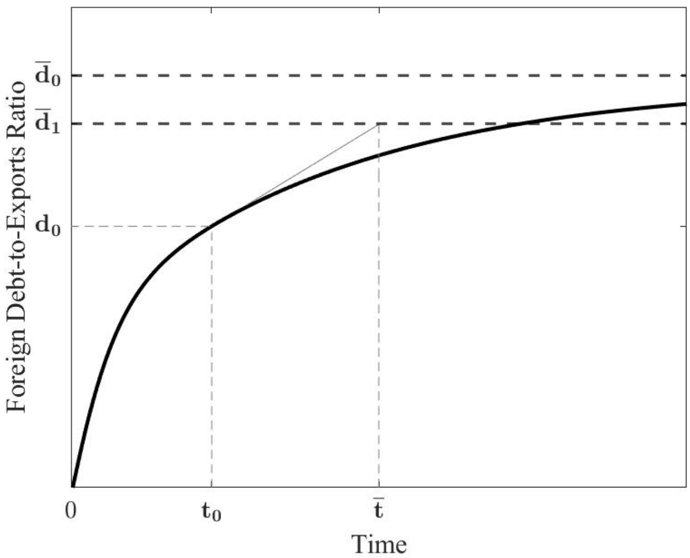


FIGURE 4.1: *Foreign Debt-to-Exports Ratio and Shock in $\bar{d}$*

period t_0, an international shock in global financial liquidity reduces the upper limit to external indebtedness from $\bar{d}_0$ to $\bar{d}_1$. The new upper limit for d is no longer consistent with the equilibrium ratio. Hence, fiscal policy management must bring public expenditure share in autonomous demand towards a value compatible with the new limit to foreign debt-to-income ratio.

The speed of this adjustment depends on the period in which debt would surpass the threshold $\bar{d}_1$. An approximation for this period can be obtained through a Taylor expansion of the foreign debt-to-exports ratio. We denote this linear approximation as $\bar{t}$.[24] Evaluating $\dot{d}$ in the period of the shock gives us the expression below.

$$\bar{t} = t_0 + \frac{\bar{d}_1 - d_0}{\dot{d}_0} \qquad [4.60]$$

Where $\dot{d}_0$ corresponds to the change in d evaluated in period t_0.

$$\dot{d}_0 = \frac{m}{(1-\sigma_0)z_0} - 1 + (r - g_X)d_0 \qquad [4.61]$$

Equation 4.60 defines the time horizon in which fiscal policy can act before the debt-to-exports ratio achieves its upper limit. Thus, the difference $\bar{t} - t_0$ defines the time interval

[24] A higher-order Taylor expansion can provide a more precise estimate. We use a linear approximation in order to keep the analysis simple and emphasize the theoretical argument.

within which such changes must take place. We can, thus, define that the ratio between public expenditures and total autonomous demand changes continuously at a rate given by equation 4.62. This equation sets the proportional change in σ, happening in each instant of time, required to avoid that d exceeds $\bar{d}$. Hence, this fiscal policy provides a gradual adjustment in σ since the change in this variable is distributed through several periods.

$$\dot{\sigma}_0 = \frac{\bar{\sigma} - \sigma_0}{\bar{t} - t_0} \tag{4.62}$$

We can now substitute $\dot{\sigma}_0$ in equation 4.46 to obtain a rule for g_{Gt}. Equation 4.46 determines $\dot{\sigma}$ according to the current level of the parameter and the difference between g_{Gt} and g_{Xt}. By isolating g_{Gt} in this equation, we obtain the following rule for the fiscal policy.

$$g_{Gt} = g_X + \frac{\dot{\sigma}_0}{\sigma_0(1 - \sigma_0)} \tag{4.63}$$

The second term of the right-hand-side is negative, according to the definition of the problem. Note that the concern with external debt convergence appears when $\bar{\sigma} < \sigma_0$, which, in turn, means that $\dot{\sigma}_0$ must be negative. Therefore, equation 4.63 defines the growth rate of public expenditure consistent with the objective of reducing the share of public expenditure in autonomous demand. It is given by the growth rate of exports minus the required change in the share for each period (that is, $\dot{\sigma}_0$) divided by the product $\sigma_0(1 - \sigma_0)$.

Nevertheless, we can conceive an opposite case in which the economy converges towards a d smaller than $\bar{d}$. If this is the case, fiscal policy can lead σ to a larger value of $\bar{\sigma}$ by setting the growth rate of public expenditures temporarily above the growth rate of exports. The rule can follow the same principle presented above, with the opposite sign. If such policy is executed, it leads the economy to a permanently higher output than if it had not been executed.

Returning to our example, the rule in equation 4.63 defines a growth rate for public expenditure smaller than the growth rate of exports. In turn, that leads to the desired outcome of this policy, *i.e.*, the decrease in the share of government in autonomous expenditures (σ). Nevertheless, each instant σ falls, the whole curve d is shifted downwards, as shown in figure 4.2. This shift, in turn, changes the estimate of the period in which the d achieves the limit. Now, this period corresponds to $\bar{t}_1$. Considering this change, the process described above can be repeated periodically, making the adjustment of σ even smoother. In this case, the fiscal policy rule is updated

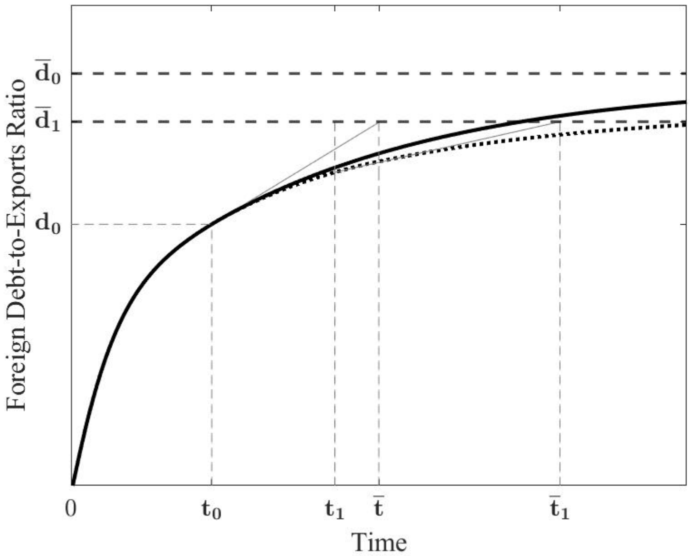


FIGURE 4.2: *Foreign Debt-to-Exports Ratio and Fiscal Policy*

periodically, changing g_{Gt} according to the shifts in the d curve.

This policy alternative has the advantage of being very gradual, avoiding a sudden interruption on the growth path, with its economic and social consequences. However, such policy requires framing the issue of external debt as a matter of long term equilibrium, which is possible when the short-term liquidity in foreign currency is guaranteed.

4.7 Simulations

We rely on numerical simulations to analyze five different experiments. All of them start from a steady-state position, in which both components of autonomous demand grow at a 4 percent rate. Initially, the degree of capacity utilization is equal to the normal degree, and the propensity to invest is equal to its steady-state value. We discuss the evolution of foreign debt and public debt ratios, and growth of autonomous demand and output in each of the five cases.

First, we present a baseline case. In this case, both foreign debt and public debt converge to a stable positive value. Foreign-debt-to exports ratios converges to a positive value because $[m/(1-\sigma^* z^*)] - 1 > 0$. In other words, the economy accumulates external debt because it maintains trade account deficits in the equilibrium. Foreign debt-to-exports ratio converges to a stable value because $g_X > r$ in the baseline case. In turn, the public debt-to-income ratio converges to a positive value because $\sigma^* z^* - \tau > 0$. That means that the public budget presents deficits in the equilibrium. Convergence of public debt-to-income ratio results from the assumption that $g > i$, that is, output growth rate is larger than the interest rate on public debt.

The other four cases explore different features within the same framework. They keep most of the parameters of the baseline case, varying with respect to one particular characteristic to examine the effect of such change. The particularities of each case are summarized in table 4.1, with the results of the simulation for key variables. The parameters of the experiments are presented in a table in appendix E.[25]

TABLE 4.1: Summary of the Results of the Simulations

	Case 1	**Case 2**	**Case 3**	**Case 4**	**Case 5**
Name	Baseline	Explosive d	Explosive b	Fiscal Policy	Structural Change
Change	-	$r = 0.05$	$i = 0.045$	Policy rule (p.30)	$g_X = 0.045$ (p.40)
g^*	0.04	0.04	0.04	0.04	0.045
b^*	1.0126	1.0126	$+\infty$	0.8022	0.3777
d^*	4.2944	$+\infty$	4.2944	2.5000	2.3927
h^*	0.2029	0.2029	0.2029	0.2029	0.2118
z^*	0.4096	0.4096	0.4096	0.4096	0.4007
σ^*	0.4138	0.4138	0.4138	0.4039	0.3969

Figure 4.3 compares the baseline case with cases 2 and 3. Case 2 reveals the explosive dynamics for foreign debt-to-exports ratio, obtained when the interest rate on foreign debt service (r) is higher than the growth rate of exports. Case 3 shows the divergent pattern for the public debt-to-income ratio. Similarly to the previous case, the interest rate on public debt (i) is higher than the output growth rate.

[25] Simulation exercises employed the software MATLAB 2019b. The code is available upon request.

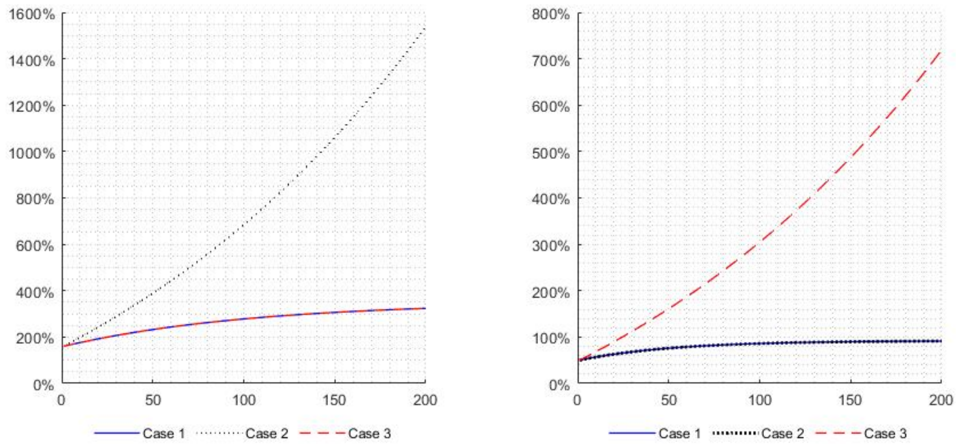


FIGURE 4.3: *Evolution of foreign debt-to-exports ratio (right) and public debt-to-income ratio (left) for Cases 1,2, and 3.*

Note that according to table 4.1, the experiments show that other than the particular debt ratio that follows an explosive path, the remaining variables converge towards equilibrium values. In fact, they converge towards the same equilibrium as the baseline case. Nevertheless, this conclusion depends on the assumption that the fast increase in debt ratios does not affect the parameters. That may not be the case in reality. A fast increase in public debt, for instance, may cause a fall in the growth rate of public expenditures, changing the pattern observed in the simulation. Instead, it may motivate monetary authorities to reduce i, pushing the public debt-to-income ratio to a stable path. If foreign debt-to-exports is the one following a divergent path, then above a threshold value for d capital inflows may cease. That makes the economy unable to pay for its external liabilities. Consequently, it may run for the support of international organizations. Sometimes that means a debt renegotiation with a lower interest rate. Sometimes financial support also requires the imposition of large real exchange rate devaluations and cuts in public expenditures. If the real devaluation is successful, it reduces the propensity to import, and reduce the propensity to consume due to its regressive impact on distribution. In any case, these different scenarios show that parameters do not tend to remain still while debt ratios follow and explosive dynamics. However, we abstract from those complex feedback effects since they do not arise from any mechanical change in the parameters but are a contingent outcome from policy decisions. We take that parameters as given, not assuming any type of policy response in these cases.[26] We can, thus, move forward to the policy choices presented in cases 4 and 5.

[26] This is not equivalent to stating that the parameters must remain constant. However, it would not be accurate to introduce mechanical adjustment in the parameters due to an explosive debt dynamics. Future research can explore alternative scenarios of economic policy in the face of increasing debt ratios.

Case 4 describes the case in which there is a ceiling to foreign debt-to-exports ratio, and fiscal policy follows the rule presented in section 4.6. This experiment builds on the same parameters as the baseline case. The only difference is that the fiscal policy rule is executed from period 30 onward. Figure 4.4 compares the performance of both debt ratios in the baseline case with case 4. It shows that fiscal policy intervention is successful in keeping the foreign debt-to-exports ratio below the threshold of $\bar{d}$. The objective of fiscal policy is to reduce the share of public expenditures on autonomous demand by temporarily slowing the pace of public expenditures growth. The fall in the steady-state value for σ implies also a fall in the equilibrium public debt-to-income ratio. In the baseline case, b converges to 1.01, while after the intervention of fiscal policy it goes to 0.80.

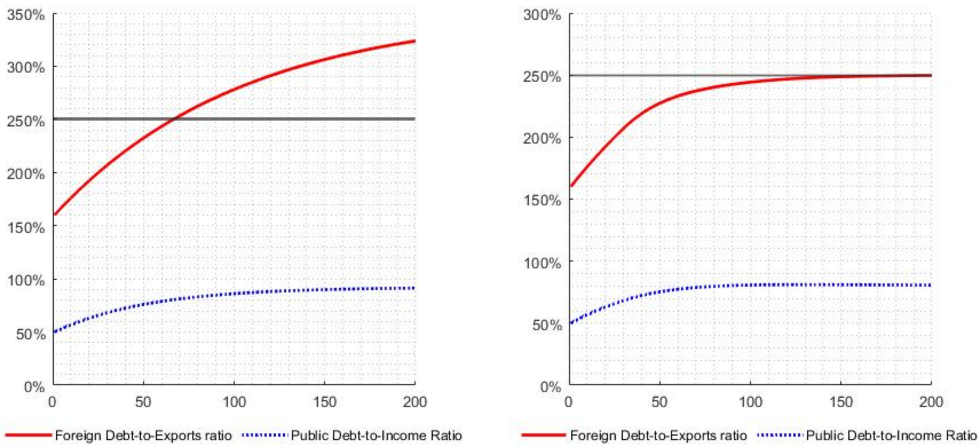


FIGURE 4.4: *Debt ratios in the baseline case (left) and the fiscal policy case (right)*

Additional details on case 4 are presented in figure 4.5. The figure shows the continuous fall in the share of public expenditures in autonomous demand (σ) after the intervention of fiscal policy. This share slowly converges to $\bar{\sigma}$, which corresponds to the share of public expenditure in autonomous demand that is compatible with the ceiling to foreign debt-to-exports ratio.

The graph at the bottom-right shows the evolution of the growth rates of output and each component of autonomous demand. Public expenditures' growth rate falls immediately after the intervention of fiscal policy. Output growth also falls in the same period, but less than public expenditures, since exports keep growing at the same rate. Both public expenditures and output growth rates converge to the growth rate of exports. This convergence happens as fiscal policy brings σ closer to $\bar{\sigma}$, implying the stabilization of the level of d. The picture also shows this adjustment is very gradual. In spite of the fall in public expenditures growth rate, it remains very close to the growth

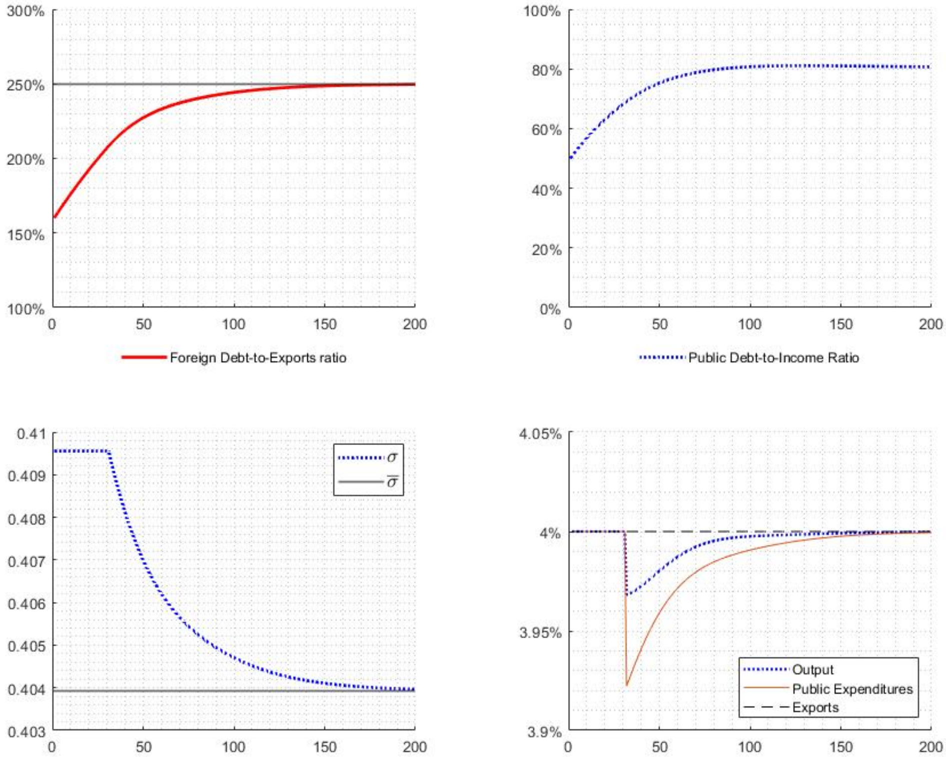


FIGURE 4.5: *Evolution of debt ratios, share of public expenditure in autonomous demand, and growth rates for case 4.*

rate of exports. The adjustment in σ is also shown to be progressive and slow. That is a desirable property of this type of policy.

In contrast with case 4, authorities may choose to execute industrial policies that cause a structural change. We address this possibility with the experiment 5, summarized in figure 4.6. Suppose that the government execute this type of policy in period 30, after rejecting the fiscal policy of case 4. If industrial policy succeeds, then the growth rate of exports accelerates a few periods after their implementation. Assume that the industrial policies do work, and take ten periods to affect the economy. In that case, from period 40 onward, the growth rate of exports accelerates. In the experiment that means increasing the growth rate of exports from 4 percent to 4.5 percent. In line with the Balance of Payments constrained growth tradition, a higher growth of exports may be associated with an increase of the income-elasticity of exports. That may happen as the economy develops production in more technologically intensive industries (Araujo and Lima, 2007; Cimoli et al., 2020, 2009).[27]

[27] Naturally, the relation among industrial policies, structural change, and growth is complex. We cannot

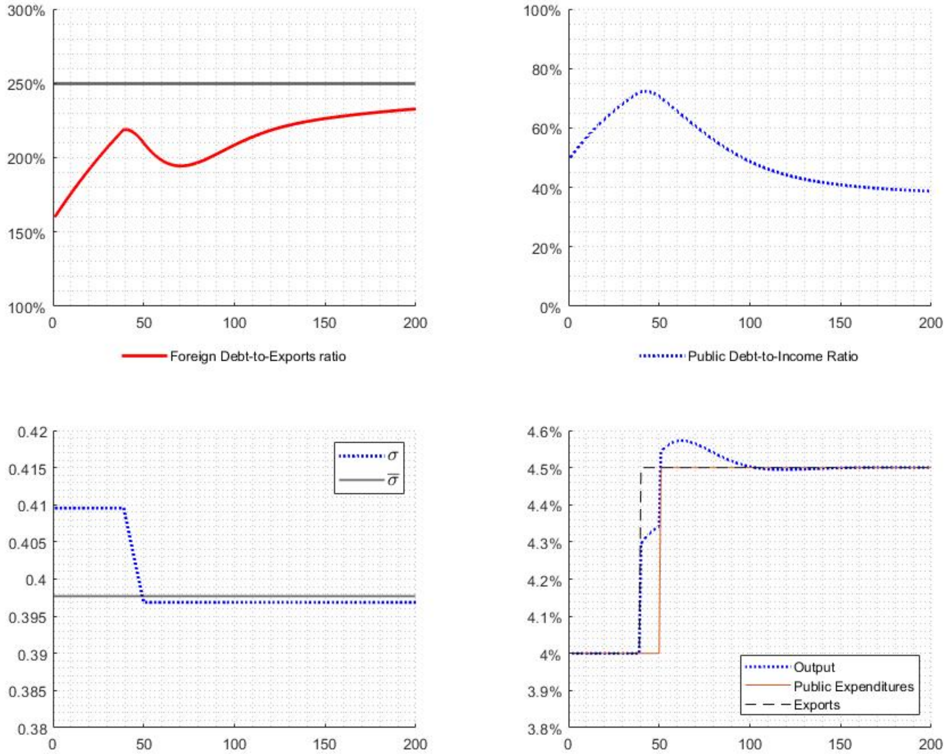


FIGURE 4.6: *Evolution of debt ratios, share of public expenditure in autonomous demand, and growth rates for case 5.*

In this case there is a new $\bar{\sigma}$ (value for the share of public expenditure compatible with the ceiling to foreign debt-to-exports ratio), given the higher growth rate of exports for the same $\bar{d}$. Note that the $\bar{\sigma}$ of case 5 is smaller than the $\bar{\sigma}$ of case 4. A new steady-state can only be achieved if public expenditures growth rate accelerates, reaching the new growth rate of exports. However, that can only happen after σ becomes smaller or equal to $\bar{\sigma}$. In the simulation, that happens in period 51. Then, after this period the economy converge to a new steady-state.

Initially, output growth rate follows the original steady-state. It accelerates after the increase in the growth rate of exports. In the following periods, it keeps accelerating, as σ falls, increasing the impact of exports on output growth. Finally, when the public

ensure that the required growth of exports included in the experiment is necessarily obtained. The effectiveness of these policies varies with the type of measures executed and with the intensity of such measures. In fact, this simulation can also be interpreted as providing an indication of what is the extent of the boost given to exports required to avoid fiscal austerity and still achieve stability of the debt ratios. In practice, policymakers can choose among many different combinations of the two pure cases (4 and 5) compared here.

expenditures growth rate adjusts to exports growth, output growth converges to a new steady-state. It becomes temporarily higher than the growth rate of autonomous demand due to the increase in the propensity to invest, which is necessary to restore normal utilization after an acceleration of growth. After a while, output growth approaches the growth rate of autonomous expenditures in a new fully adjusted position.

The foreign debt-to-exports ratio also converges and remains below $\bar{d}$ in case 5. In turn, the public debt-to-income ratio converges to a lower value than in case 4. Lower b^* in case 5 is due to the higher steady-state growth rate of output, the lower share of public expenditure in autonomous demand (σ^*), and the lower ratio of autonomous demand to total output (z^*). The lower value for z^* is also associated with a higher h^*. As shown in table 4.1, equilibrium propensity to invest is higher in case 5 than in the other cases because the economy presents a higher output growth rate. Therefore, if the chosen industrial policies successfully affect exports growth, then case 5 provides a better performance in terms of output growth than the fiscal policy executed in case 4. The growth rates of these two cases are compared in figure 4.7.

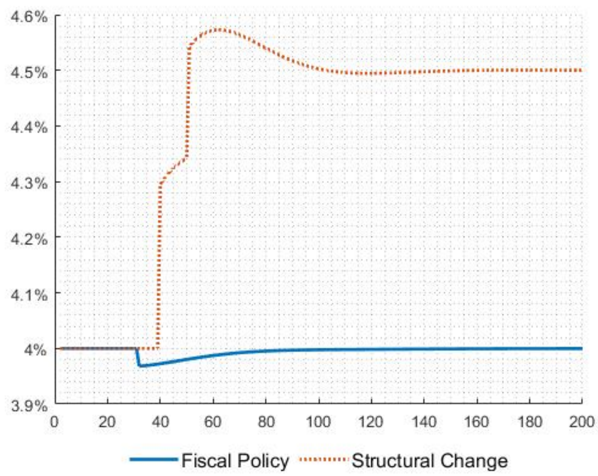


FIGURE 4.7: *Output growth rate in Case 4 (Fiscal Policy) and Case 5 (Structural Change).*

The simulated experiments confirm theoretical results presented in the previous section. Interest rate smaller than growth rate is crucial for long run stability of public debt. International interest rate smaller than exports growth. The fiscal policy proposed in section 4.5 successfully keeps the foreign debt-to-exports ratio below $\bar{d}$ by adjusting the share of public expenditures in autonomous demand. After the adjustment in σ is finished, public expenditure can follow the same pace as exports, keeping a constant σ and allowing the economy to converge to a steady-state compatible with the limit to external debt. The fall in σ also imply a decrease in the equilibrium level of public debt-to-income ratio in the scenario with the fiscal policy. The graphs in figure 4.5 show the adjustment in σ is slow and gradual. The impact of the fiscal policy on output growth also reveals a gradual adjustment of this variable. The last scenario shows that debt ratios can converge under a better economic performance when structural policies are successfully employed. Authors have emphasized the importance of these policies to relax the external constraint by increasing the income-elasticity of exports (Araujo and Lima, 2007; Cimoli et al., 2020, 2009; Thirlwall, 2019). Such policies allow for the improvement of the economic performance. Indeed, case 5 presented a higher output growth rate than previous cases. It also ensured convergence of the foreign debt-to-export ratio to a value below $\bar{d}$. The public-debt-to income ratio converged to a smaller value than in the other cases, since output growth was larger and both σ and z^* were smaller.

Overall, the five experiments show that there is no *a priori* obstacle to the long run sustainability of growth led by autonomous demand as determined by public expenditures and exports.

4.8 Final Remarks

This chapter presented a supermultiplier model for an open economy with government in which autonomous demand is composed of public expenditure and exports. The framework allows for assessing the long run stability of growth, and public and foreign debt ratios. The convergence of public debt-to-income ratio requires that output growth rate is larger than the interest rate on debt service. In turn, the convergence of foreign debt-to-exports ratio depends on an analogous condition, *i.e.*, that exports growth is larger than the interest rate on foreign debt service. The model also showed that, in the presence of two sources of autonomous demand, equilibrium values for debt ratios vary with the share of each expenditure in total autonomous demand. The equilibrium value for the public debt-to-income ratio increases with the share of government in autonomous demand. However, it converges to a stable value even in the extreme case happening when government fully dominates autonomous demand. Equilibrium foreign debt-to-exports ratio also increases with the share of exports in autonomous demand, but it diverges to infinity in the extreme case in which this share equals zero. The relevance of those shares to equilibrium debt ratios means that fiscal policy can manage public expenditure to bring debt ratios towards desirable levels. Hence, a fiscal policy rule is proposed in the chapter, according to which government moderates the growth of public expenditure to meet a ceiling in the foreign debt-to-exports ratio, associated with constraints in international liquidity. The external constraint to growth in open economies appears here in the form of a limit to foreign indebtedness. We further show that in this supermultiplier model, Thirlwall's Law emerges as a particular result of the long run growth path. Five simulated experiments support our main conclusions.

Overall, there is no *a priori* obstacle to the long run sustainability of growth led by autonomous demand as determined by public expenditures and exports. Furthermore, the fiscal policy rule succeeds in keeping foreign debt-to-exports ratio below the given threshold. This policy, however, has a cost in terms of average growth rate. Such a cost may be mitigated with the introduction of industrial policies that increase the income elasticity of exports. Although the effect of industrial policies on growth and structural change is not guaranteed, if this approach is successful it may ensure the convergence of debt ratios with a better performance in terms of growth. Naturally, a variety of combinations of those (and other) policies are available in reality.

Appendix

A Equilibrium growth and the share of each autonomous expenditure

This appendix briefly describe some relations between the proportion of public expenditures in autonomous expenditures (σ) and the rate of growth of public expenditures (g_G) and exports (g_X). Those relations are useful to justify the analysis developed in the chapter.

I start rewriting here equations 4.19 and 4.20.

$$g_Z = \sigma_t g_{Gt} + (1 - \sigma_t) g_{Xt}$$

$$\sigma_t = \frac{G_t}{Z_t}$$

Operating derivatives with respect to time in both sides of the last equation gives us:

$$\dot{\sigma}_t = \frac{\dot{G}_t Z_t - G_t \dot{Z}_t}{Z_t^2}$$

Then,

$$\dot{\sigma}_t = \frac{\dot{G}_t}{Z_t} - \sigma_t g_{Zt}$$

By rearranging the relation in equation 4.20, to substitute Z_t in the last equation, we obtain:

$$\dot{\sigma}_t = \sigma_t g_{Gt} - \sigma_t g_{Zt} \qquad [4.64]$$

Substituting the g_{Zt} and rearranging, we obtain:

$$\dot{\sigma}_t = \sigma_t (1 - \sigma_t)(g_{Gt} - g_{Xt}) \qquad [4.65]$$

Now, let us take the derivatives with respect to time of the expression for the growth rate of autonomous demand, in equation 4.19.

$$\dot{g}_{Zt} = \dot{\sigma}_t g_{Gt} + \sigma_t \dot{g}_{Gt} - \dot{\sigma}_t g_{Xt} + (1 - \sigma_t) \dot{g}_{Xt}$$

Rearranging, we get:

$$\dot{g}_{Zt} = \dot{\sigma}_t(g_{Gt} - g_{Xt}) + \sigma_t\dot{g}_{Gt} + (1 - \sigma_t)\dot{g}_{Xt}$$

Finally, by substituting the value for $\dot{\sigma}_t$ as in equation 4.65, we obtain:

$$\dot{g}_{Zt} = \sigma_t(1 - \sigma_t)(g_{Gt} - g_{Xt})^2 + \sigma_t\dot{g}_{Gt} + (1 - \sigma_t)\dot{g}_{Xt} \quad [4.66]$$

Let us now discuss under which conditions we obtain that the growth rate of autonomous expenditures is constant, so that the derivative in equation 4.66 is equal to zero. It is easy to see that if public expenditure is null (and thus, $\sigma_t = 0$), stability in total autonomous expenditures growth rate is exactly the same as stability in exports growth rate — putting it differently, $\dot{g}_{Zt} = 0$ requires that $\dot{g}_{Xt} = 0$. In the contrary, if exports are null ($\sigma_t = 1$), the same reasoning show us that the stability in autonomous demand requires stability in public expenditures.

Apart from these two extreme cases, there are two further conditions that can define stability in the growth rate of autonomous demand. First, this can happen if both exports and public expenditures grow at the same constant rate. In this case, $\dot{g}_{Gt} = \dot{g}_{Xt} = 0$ *and* $g_{Gt} = g_{Xt}$, so that clearly in equation 4.66, the derivative of Z_t with respect to time goes to zero.

The last possibility arises if we allow the growth rate of exports and public expenditure to differ from each other. We can see in equation 4.65 that this difference in the two expenditures growth rate implies continuous changes in the value of σ, given that a higher (smaller) growth rate of public expenditures with respect to exports will cause a higher (lower) ratio of public expenditures to autonomous demand. In this case, we can have a constant value for g_{Zt} only under a specific condition. Rearranging equation 4.66, we obtain that this holds as long as $\dot{g}_{Gt}$ and $\dot{g}_{Xt}$ move in opposite directions and according with the rule in equation 4.67:

$$\dot{g}_{Gt} = -(1 - \sigma_t)(g_{Gt} - g_{Xt})^2 - \left[\frac{(1 - \sigma_t)}{\sigma_t}\right]\dot{g}_{Xt} \quad [4.67]$$

This is clearly an arbitrary condition to be imposed on the dynamics of public expenditure. Thus, we can conclude that the more general situation, the stability in the growth rate of autonomous expenditures requires that public expenditures and exports grow at the same constant rate, implying also that σ_t remains stable. This is a basic feature to determine the equilibrium within the supermultiplier model, which requires the stability of g_{Zt}. It is important to point that this relations do not imply causality from g_X to g_G or vice-versa. The results presented here only discuss the equilibrium and stability conditions, and do not claim any type of constraint to the autonomous expenditures.

B Stability of the supermultiplier in an open economy with public expenditure

In this appendix, we analyze the stability of the version of the Sraffian supermultiplier model presented in section 4.3.1. This analysis follows closely the stability analysis provided by Freitas and Serrano (2015). Nevertheless, we consider an additional equation describing the evolution of government's share in autonomous demand (σ). Moreover, as we deal with an open economy with government, we must also account for a tax rate (τ) and the propensity to import (m) as part of the supermultiplier.

The three equations relevant for the stability analysis were presented in section 2.1 and are rewritten below.

$$\dot{u}_t = u_t \left[\sigma_t g_{Gt} + (1-\sigma_t) g_{Xt} + \frac{h_t \gamma (u_t - u_n)}{1 - c(1-\tau) - h_t + m} - \left(\frac{h_t}{v} \right) u_t + \delta \right] \qquad [4.68]$$

$$\dot{h}_t = h_t \gamma (u_t - u_n) \qquad [4.69]$$

$$\dot{\sigma}_t = \sigma_t (1 - \sigma_t)(g_{Gt} - g_{Xt}) \qquad [4.70]$$

We also repeat here the equilibrium values for these three variables. Capacity utilization converges to the normal rate, $u^* = u_n$. In turn, propensity to invest depends on the equilibrium growth rate, depreciation rate, normal rate of capacity utilization and the capital-output ratio: $h^* = \frac{v}{u_n}(g_Z + \delta)$. σ achieves equilibrium at any level when the two autonomous expenditures grow at the same rate. We denote this equilibrium level as σ^*.

The Jacobian matrix evaluated in the equilibrium is defined by the expression below.

$$J^* = \begin{bmatrix} \left[\frac{d\dot{h}}{dh}\right]_{h^*,u^*,\sigma^*} & \left[\frac{d\dot{h}}{du}\right]_{h^*,u^*,\sigma^*} & \left[\frac{d\dot{h}}{d\sigma}\right]_{h^*,u^*,\sigma^*} \\ \left[\frac{d\dot{u}}{dh}\right]_{h^*,u^*,\sigma^*} & \left[\frac{d\dot{u}}{du}\right]_{h^*,u^*,\sigma^*} & \left[\frac{d\dot{u}}{d\sigma}\right]_{h^*,u^*,\sigma^*} \\ \left[\frac{d\dot{\sigma}}{dh}\right]_{h^*,u^*,\sigma^*} & \left[\frac{d\dot{\sigma}}{du}\right]_{h^*,u^*,\sigma^*} & \left[\frac{d\dot{\sigma}}{d\sigma}\right]_{h^*,u^*,\sigma^*} \end{bmatrix} \quad [4.71]$$

The elements $\left[\frac{d\dot{h}}{dh}\right]_{h^*,u^*,\sigma^*}$ $\left[\frac{d\dot{h}}{du}\right]_{h^*,u^*,\sigma^*}$, $\left[\frac{d\dot{u}}{dh}\right]_{h^*,u^*,\sigma^*}$, and $\left[\frac{d\dot{u}}{du}\right]_{h^*,u^*,\sigma^*}$ are trivially obtain and coincide with the results of Freitas and Serrano (2015).

We are thus left to compute the remaining elements of the Jacobian matrix, that is, the elements of the third row and third column.

It is easy to see that:

$$\left[\frac{d\dot{h}}{d\sigma}\right] = 0 \quad [4.72]$$

In turn:

$$\left[\frac{d\dot{u}}{d\sigma}\right] = u_t g_{Gt} - u_t g_{Xt} = u_t(g_{Gt} - g_{Xt}) \quad [4.73]$$

Evaluating this derivative in the equilibrium means substituting $u_t = u_n$ and making $g_{Gt} = g_{Xt}$. In that case,

$$\left[\frac{d\dot{u}}{d\sigma}\right]_{h^*,u^*,\sigma^*} = 0 \quad [4.74]$$

As σ does not depend on h or u (see equation 4.70), then the partial derivatives $\left[\frac{d\dot{\sigma}}{dh}\right]$ and $\left[\frac{d\dot{\sigma}}{du}\right]$ are trivially equal to zero.

Finally, we must compute $\left[\frac{d\dot{\sigma}}{d\sigma}\right]$. First, let us rewrite equation 4.70 as follows:

$$\dot{\sigma} = \sigma_t(g_{Gt} - g_{Xt}) - \sigma_t^2(g_{Gt} - g_{Xt}) \quad [4.75]$$

Then, we have:

$$\left[\frac{d\dot{\sigma}}{d\sigma}\right] = (g_{Gt} - g_{Xt}) - 2\sigma_t(g_{Gt} - g_{Xt}) = (1 - 2\sigma_t)(g_{Gt} - g_{Xt}) \quad [4.76]$$

Evaluating this derivative in the equilibrium implies plugging $\sigma_t = \sigma^*$ and making $g_{Gt} = g_{Xt}$.

Hence:

$$\left[\frac{d\dot{\sigma}}{d\sigma}\right]_{h^*,u^*,\sigma^*} = 0 \qquad [4.77]$$

Thus, we obtain:

$$J^* = \begin{bmatrix} 0 & \gamma(g_Z+\delta)\left(\frac{v}{u_n}\right) & 0 \\ \frac{-u_n^2}{v} & (g_Z+\delta)\left(\frac{\gamma v}{1-c(1-\tau)-\left(\frac{v}{u_n}\right)(g_Z+\delta)+m} - 1\right) & 0 \\ 0 & 0 & 0 \end{bmatrix} \qquad [4.78]$$

Local stability requires obtaining the eigenvalues of the matrix 4.78. The characteristic polynomial of 4.78 is given by the equation below.

$$\lambda^3 - \lambda^2 \left[(g_Z+\delta)\left(\frac{\gamma v}{1-c(1-\tau)-\left(\frac{v}{u_n}\right)(g_Z+\delta)+m} - 1\right)\right] + \lambda u_n \gamma (g_Z+\delta) = 0$$

[4.79]

From the characteristic polynomial, we obtain that $\lambda = 0$ is one of the eigenvalues of the matrix 4.78. The other two roots can be obtained from the following equation.

$$\lambda^2 - \lambda \left[(g_Z+\delta)\left(\frac{\gamma v}{1-c(1-\tau)-\left(\frac{v}{u_n}\right)(g_Z+\delta)+m} - 1\right)\right] + u_n \gamma (g_Z+\delta) = 0 \quad [4.80]$$

Since the first and the third coefficients of the second degree equation (4.80 are positive, its two roots are negative as long as the second coefficient is positive. In other words, the two remaining eigenvalues are negative if the following inequality holds:

$$-\left[(g_Z+\delta)\left(\frac{\gamma v}{1-c(1-\tau)-\left(\frac{v}{u_n}\right)(g_Z+\delta)+m} - 1\right)\right] > 0 \qquad [4.81]$$

The inequality above holds whenever the condition below is attended.

$$\gamma v + c(1-\tau) + \frac{v}{u_n}(g_Z + \delta) - m < 1 \qquad [4.82]$$

4.82 is analogous to the condition found by Freitas and Serrano (2015). In fact, if we set $\tau = m = 0$, we obtain the same condition they found in the model of a closed economy without government.

Condition 4.82 ensures that the other two roots of the characteristic polynomial, and thus the other two eigenvalues, are negative.

Therefore, the matrix 4.78 has one eigenvalue equal to zero and two eigenvalues that are negative. The eigenvalue equal to zero shifts the level of the equilibrium of the system, but does not affect the conditions of asymptotic convergence. The fact that the other two eigenvalues are smaller than zero, however, ensures the asymptotic convergence of the system.

Form an economic interpretation, inequality 4.82 implies that the model is locally stable when the expanded marginal propensity to spend (that is, the marginal propensity to spend added of the term γv associated to the accelerator investment function) is lower than one (Freitas and Serrano, 2015).

Taxation and imports represent two leakages of induced demand. The presence of taxation and propensity to import reduces the value of the expanded marginal propensity to spend, easing the satisfaction of inequality 4.82. Therefore, an open economy with government is less vulnerable to instability coming from economic growth and the capital stock adjustment principle (*i.e.*, the flexible accelerator).

C Sensitivity Analysis

This appendix reports the results of the sensitivity analysis performed in the dynamic system presented in section 3.3. We tested the robustness of the equilibrium of the model in face of random shocks in the main variables determining the dynamics: the interest rate (i), the international rate (r), the growth rate of exports (g_X), the growth rate of public expenditure (g_G), propensity to import (m), tax rate (τ), and the sensitivity of the investment share to deviations of capacity utilization concerning normal capacity (γ).

We analyzed three scenarios.

In the first scenario, a permanent random shocks is added to four parameters: i, r, g_G, and g_X. Figure 4.8 presents the results of the Monte Carlo simulations of this scenario. While capacity utilization and the propensity to invest converge, the debt ratios and the government's share in autonomous demand present a widening range of values in the time interval, due to the permanent difference between the growth rates of the two autonomous expenditures (g_G, g_X).

The second scenario maintains the random shocks in the same parameters, but establishes the condition that the shocks affect g_G and g_X in the same way. Therefore, in this scenario the growth rate of autonomous demand varies, due to the random shocks. However, the growth rate of government and exports is always equal. As a consequence of this condition, all the variables present a convergence within a stable interval in the Monte Carlo simulations. The results can be seen in figure 4.9.

Finally, the third scenario includes random shocks in additional parameters, but maintains the equality between g_G and g_X. Now we test the sensitivity of the equilibrium to changes in the interest rate, the international interest rate and the growth rate of autonomous demand, as before, in addition to changes in the propensity to import (m), tax rate (τ), and the sensitivity of the investment share to deviations of capacity utilization concerning normal capacity (γ). Once again, the variables converge to equilibrium within a stable interval, as seen in figure 4.10.

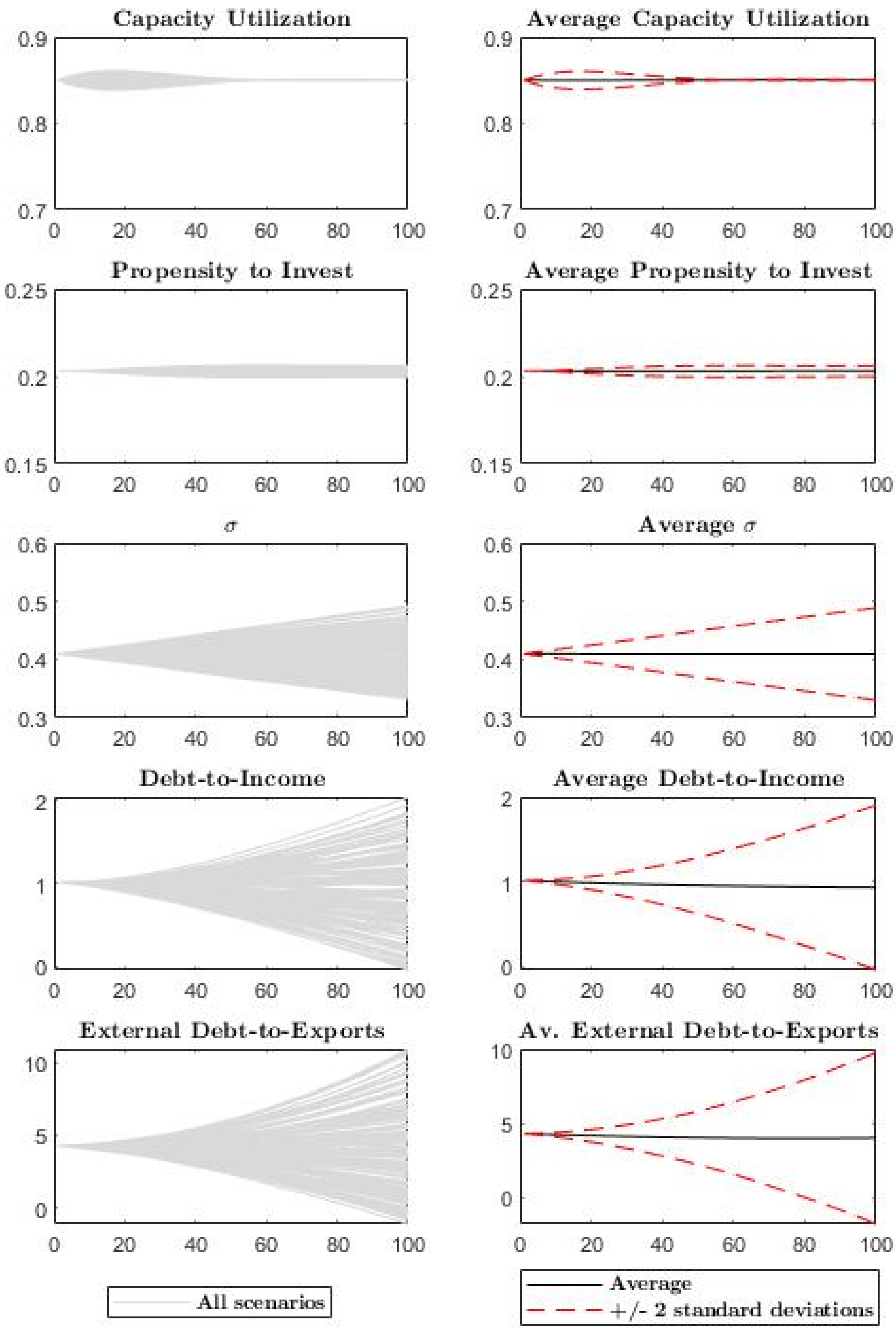


FIGURE 4.8: *Sensitivity analysis. Case 1: shocks in i, r, g_G, and g_X.*

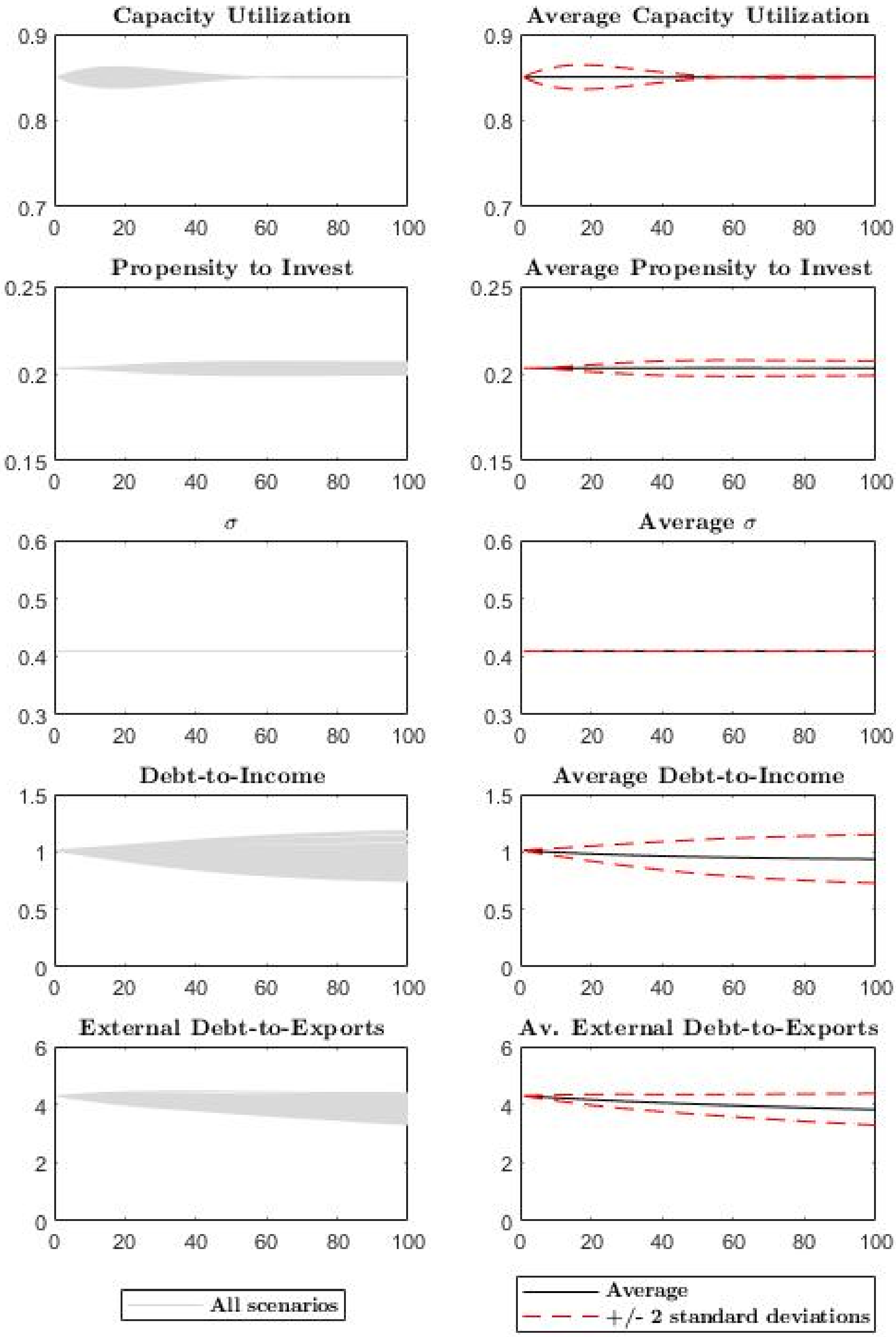


FIGURE 4.9: *Sensitivity analysis. Case 2: shocks in i, r, g_Z, keeping $g_G = g_X$.*

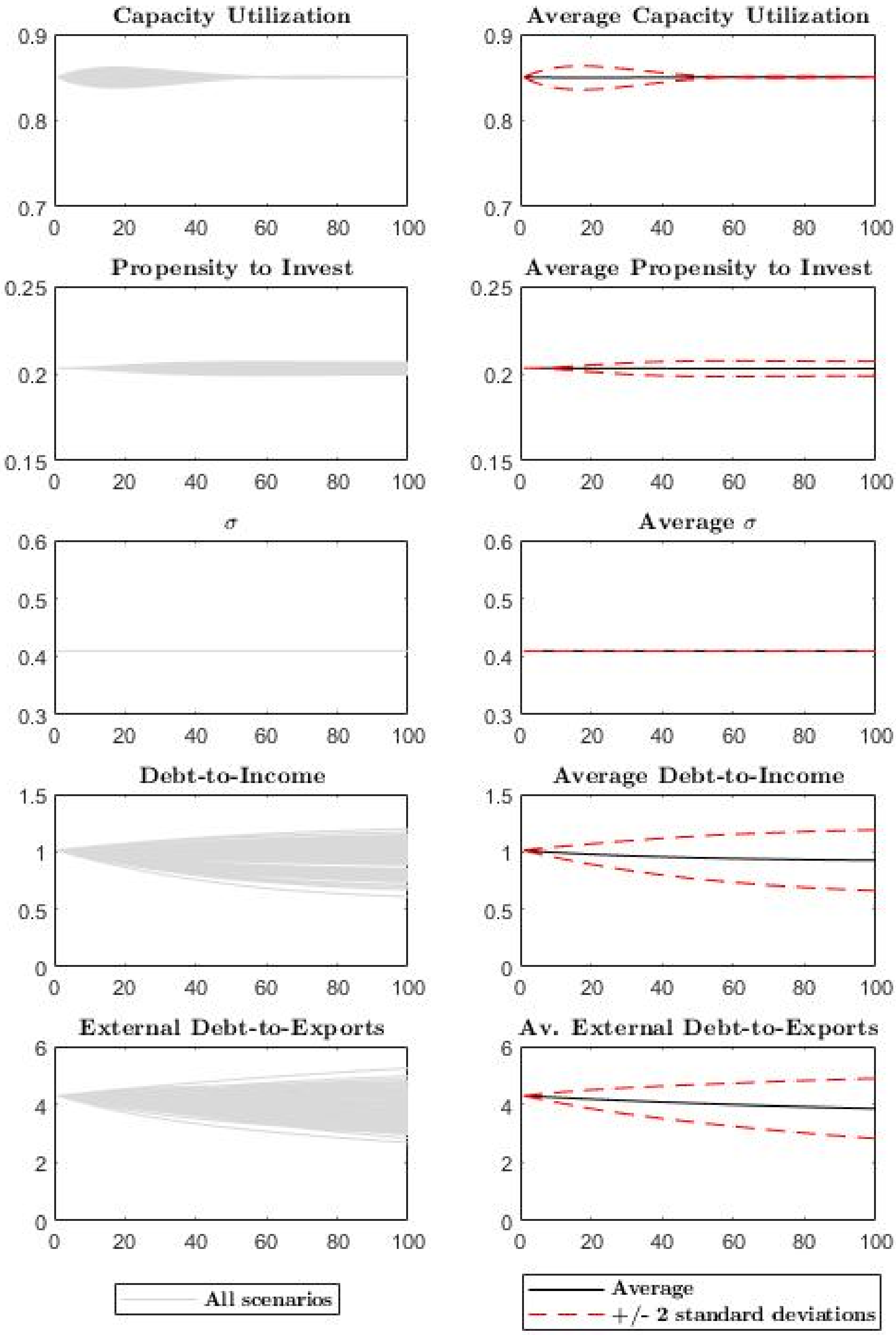


FIGURE 4.10: *Sensitivity analysis. Case 3: shocks in $i, r, g_Z, m, \tau, \gamma$, keeping $g_G = g_X$.*

D Discrete time

This appendix presents a discrete time version of the model developed in this chapter. The discrete time model follows the same structure and the same assumptions of the original model. This version is required for the simulation exercise.

Output Level

As in the original model, equilibrium in the goods market implies aggregate output equals aggregate demand, which is given by consumption, investment, public expenditure, exports and imports.

$$Y_t = C_t + I_t + G_t + X_t - M_t$$

Consumption depends on propensity to consume (c), and on current disposable income.

$$C_t = c(1-\tau)Y_t$$

Likewise, imports depend on the current income and the propensity to import (m):

$$M_t = mY_t$$

Investment, in turn, is given by the propensity to invest times current income.

$$I_t = h_t Y_t$$

Public expenditure and exports are autonomous with respect to current income, being added in the term Z_t. We can, then, determine according to the level of autonomous expenditures and the supermultiplier.

$$Y_t = \left(\frac{1}{1-c(1-\tau)-h_t+m}\right) Z_t$$

Capacity Utilization

The degree of capacity utilization is defined as the ratio between output and potential output.

$$u = \frac{Y_t}{Y_{Kt}}$$

Since the capital-output ratio is constant, the growth rate of potential output is equal to the growth rate of capital stock, *i.e.*, the accumulation rate. Hence, the rate of change in capacity utilization follows the expression below.

$$\hat{u}_t = \frac{g_t - g_{Kt}}{1 + g_{Kt}}$$

And the change in the degree of capacity utilization in each period is given by the expression below.

$$\Delta u_t = u_{t-1}\left(\frac{g_t - g_{Kt}}{1 + g_{Kt}}\right)$$

However, we still need to determine g_{Kt}.

$$g_{Kt} := \frac{K_t - K_{t-1}}{K_{t-1}} = \frac{I_{t-1}}{K_{t-1}} - \delta$$

Finally, with the same operations of the footnote 4, we can obtain the equation below.

$$g_{Kt} = \frac{h_{t-1}}{v}u_{t-1} - \delta$$

The propensity to invest

Propensity to invest changes when the degree of capacity utilization deviates from normal capacity, according to the parameter γ.

$$\Delta h_t = h_{t-1}\gamma(u_{t-1} - u_n)$$

Thus, the rate of change in the propensity to invest can be described as follows.

$$\hat{h}_t = \gamma(u_{t-1} - u_n)$$

Output Growth

Now, we are able to determine output growth (g_t), according to the change in the supermultiplier due to the variation in the propensity to invest and to the growth in autonomous expenditures.

$$g_t = \frac{h_{t-1}\hat{h}_t}{1 - c(1-\tau) - h_{t-1}(1+\hat{h}_t) + m} + g_{Zt} + \left[\frac{h_{t-1}\hat{h}_t}{1 - c(1-\tau) - h_{t-1}(1+\hat{h}_t) + m}\right] g_{Zt}$$

Autonomous demand varies proportionally with public expenditures and exports, and to the share of each expenditure in autonomous demand. We define σ as the share of public expenditure in autonomous demand. Thus, $\sigma_t = G_t/Y_t$.

$$g_{Zt} = \sigma_{t-1}g_{Gt} + (1 - \sigma_{t-1})g_{Xt}$$

Change in σ follows the expression below.

$$\Delta\sigma_t = \frac{\sigma_{t-1}(1-\sigma_{t-1})(g_{Gt} - g_{Xt})}{1 + \sigma_{t-1}g_{Gt} + (1-\sigma_{t-1})g_{Xt}}$$

Which can be written as:

$$\Delta\sigma_t = \frac{\sigma_{t-1}(1-\sigma_{t-1})(g_{Gt} - g_{Xt})}{1 + g_{Zt}}$$

Public Debt

The relevant variable here is public debt-to-income ratio, denoted as b_t. Changes in public debt in each period depend on the primary surplus/deficit and on the interest payments of the debt service.

$$\Delta B_t = G_t - \tau Y_t + iB_{t-1}$$

Hence,

$$b_t = \sigma_t z_t - \tau + \left[\frac{(1+i)}{(1+g_t)}\right] b_{t-1}$$

Finally,

$$b^* = (\sigma^* z^* - \tau)\left(\frac{1+g^*}{g^*-i}\right)$$

Foreign debt

We focus in the foreign debt-to-exports ratio, denoted as d_t. According to the assumptions of the model, foreign debt change in each period depends on the trade balance and on foreign debt service payments.

$$\Delta D_t = M_t - X_t + rD_{t-1}$$

Hence, the debt-to-exports ratio can be expressed as in the equation below.

$$d_t = \frac{M_t}{X_t} - 1 + \left[\frac{(1+r)}{(1+g_{Xt})}\right] d_{t-1}$$

Finally, by setting $d_t - d_{t-1} = 0$, we obtain the equilibrium foreign debt-to-exports ratio.

$$d^* = \left[\frac{m}{(1-\sigma^*)z^*} - 1\right]\left(\frac{1+g_X}{g_X - r}\right)$$

E Simulation Parameters and Equilibrium values

Table E.1 presents the parameters employed in the simulations.

Table E.2 displays the initial values of the simulations. Finally, table E.3 presents the equilibrium values for the main variables. The different results for equilibrium come from the change in each of the four cases with respect to the baseline case, which is also shown in the table.

TABLE E.1: Parameters

Parameter	Value
g_G	0.04
g_X	0.04
c	0.075
τ	0.15
m	0.25
γ	0.05
u_n	0.85
v	1.50
δ	0.075
i	0.02
r	0.03

TABLE E.2: Initial Values

Variable	Value
G_0	120.000
X_0	173.000
σ_0	0.4138
h_0	0.2029
u_0	0.85
b_0	0.5
d_0	1.6

TABLE E.3: Simulations Result

	Case 1	Case 2	Case 3	Case 4	Case 5
Name	Baseline	Explosive d	Explosive b	Fiscal Policy	Structural Change
Change	-	$r = 0.05$	$i = 0.045$	Policy rule (p.30)	$g_X = 0.045$ (p.40)
g^*	0.04	0.04	0.04	0.04	0.045
b^*	1.0126	1.0126	$+\infty$	0.8022	0.3777
d^*	4.2944	$+\infty$	4.2944	2.5000	2.3927
h^*	0.2029	0.2029	0.2029	0.2029	0.2118
z^*	0.4096	0.4096	0.4096	0.4096	0.4007
σ^*	0.4138	0.4138	0.4138	0.4039	0.3969

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