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Essays in Open Economy Macroeconomics

Technological Gaps, Income Distribution and the Balance of Payments Constraint

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For my parents, Barry and Tessa, who taught me to reach for the stars. And my little giants: Barry III, Breanna, Israel, Genesis, Nathan, Kayleia.

I hope you inherit a more equal world.

Declaration

This dissertation is submitted according to the conditions of the Degree Committee of Kingston University. I certify that this dissertation is solely my own work.

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Abstract

This thesis contains four chapters. In the first chapter, I provide a structured survey of balance of payments (BP) constrained growth models. Unlike other surveys, this chapter reviews the various mechanisms of relative price adjustments, undertakes a comprehensive review of capital flows and surveys the literature on endogenous trade elasticities. The second chapter contributes to the literature on technological gaps and BP constrained growth by developing a theoretical framework to account for the ambiguous effects of capital inflows on short- and medium-run growth. The model shows that when a technological gap exists between two countries in an Economic and Monetary Union (EMU) and it exceeds a critical threshold, capital flows toward the technological laggard deteriorate its production structure and reduce its BP constrained growth rate. Several conclusions are derived. The size of the technological gap and demand-regimes are consequential for relative economic performance and regional cohesion. Capital flows within a community can produce both convergence and divergence effects. Finally, if political consensus is lacking at the regional level as to the design framework for a Fiscal Union, then the principal convergence criteria must include demand-regimes and the size of the technological gap. The third chapter endogenizes the trade elasticities as an ambiguous function of the wage share but a positive function of the inverted technological gap. When the laggard economy has a small capital goods producing sector, high inequality and conspicuous consumption, a tradeoff emerges between distribution and technological convergence. However, the tradeoff becomes less binding if an EMU provides for investments in technological innovation and emulation that assist the catching-up process. The fourth chapter incorporates the monetary economy into a three-incomes post-Kaleckian model. It demonstrates how a devaluation can induce contractionary effects by lowering the profit share and raising the loan rate. These results are driven by oligopolistic bankers who exercise market power in the bond and loan markets. Moreover, the chapter demonstrates that monetary policy increases bankers' rent share, which lowers the rate of firm-level innovation. These results imply that the effects of a devaluation depend on the degree of competition in the banking sector, the size of banks' foreign assets- and loan-capital ratios and whether or not the economy is in a regime of excess reserves.

Contents

Introduction

Much debate over the Eurozone crisis and its intra-current account imbalances have focused on the divergence in labour costs and demand across member states. At one extreme, there are scholars who argue that intra-external imbalances are driven by differences in labour cost only (Flassbeck and Lapavitsas 2016; Sinn 2014; Flassbeck and Lapavitsas 2013; Priewe 2011) and at the other extreme, others contend that asymmetric growth in demand is the key driving factor (Storm and Naastepad 2015a; Gabrisch and Staehr 2014; Diaz Sanchez and Varoudakis 2013). Stockhammer and Sotiropoulos (2014) take a balanced view and explain that both costs and demand factors matter for intra-Eurozone current account imbalances and growth divergence.

Other scholarship emphasizes the role of technological gaps in the build-up of the Eurozone crisis. In a series of publications, Reinert and his co-authors contend that the European crisis can only be properly understood in the context of dramatic deindustrialization of the Eurozone periphery, a direct consequence of abandoning the previous strategy of symmetrical integration based on Listian principles (Reinert and Kattel 2019; Reinert 2019; Reinert and Kattel 2014). Reinert (2019) emphasizes three Listian principles: 1. The preconditions for wealth, democracy and political freedom are based on a diversified manufacturing sector subject to increasing returns, 2. A nation first industrializes and is then gradually integrated into nations at the same level of development and 3. Economic welfare is a result of synergy—infrastructure, education and science. To support the latter view, several empirical studies show that the Eurozone periphery has lost value added share in medium- and high-technology exports since the introduction of the Euro (Storm and Naastepad 2015b; Botta 2014; Simonazzi et al. 2013; Reinstaller et al. 2012).

From the get-go, the Eurozone economic policy regime was not designed to serve as a transfer union. Member states are required to maintain fiscal discipline and the European Central Bank (ECB) was not designed to act as lender of last resort to member states (Stockhammer et al. 2019; 2015). Thus, the crisis in the Eurozone periphery is the consequence of a flawed design, where no lender of last resorted existed and national level stabilizers were removed without adequate centralized fiscal capacity (Lavoie 2015; De Grauwe 2013). In terms of reform of the Eurozone, several proposals exist, e.g. public investment in peripheral economies through the European Investment Bank and the establishment of a European Finance Ministry (Stockhammer et al. 2019). Some scholars like Lapavitsas (2015) question the likelihood of reform and ergo, call for a GREXIT, while others like Stiglitz (2017), call for Germany's exit from the Eurozone. Such proposals bring into sharper focus the role of the exchange rate in influencing economic performance, e.g. the growth effects of a currency devaluation in the case of a GREXIT.

Given Trump's protectionist policies and the decline in world trade, regional integration projects in developing countries have become re-energized. For example, the African Continental Free Trade Agreement was recently signed and Mercosur and the Pacific Alliance are pushing for deeper financial integration (Constantine 2018). Unfortunately, these integration projects uncritically emulate the European Model. In the case of Mercosur and the Pacific Alliance, they have paid too much attention to the convergence in interest rates in the Eurozone and too little attention to the misallocation of capital flows. Several scholars show that cross-border financial flows exceeded cross-border trade in goods (Chen et al. 2012; Diaz Sanchez and Varoufakis 2013; Lane and McQuade 2013; Waysand et al. 2010) and that capital flows were misallocated towards non-tradable and low-technology economic activities in peripheral countries (Storm and Naastepad 2016; 2015b). According to Storm and Naastepad (2015b), the basis of the misallocation was higher returns in the construction sector as compared to manufacturing and this insight underscores the explanatory power of technological gaps in driving intra-Eurozone divergences in terms of growth, labour costs and trade balances. It follows that financial integration widened the technological gap between Eurozone core and periphery (Simonazzi et al. 2013; Botta 2014), unlike the theoretical prediction.

This dissertation formalizes key channels of the Eurozone crisis with the principal aim of identifying teachable moments that can inform integration projects elsewhere. It takes the Eurozone's economic policy framework and technological gaps as the starting point. Chapter 1 presents a structured survey of the balance of payments constrained growth model, starting from its historical origins to present day. Unlike other surveys (Ribeiro 2015; Thirlwall 2011; McCombie 2011), this chapter reviews the various mechanisms of relative price adjustments and undertakes a comprehensive review of capital flows in balance of payments constrained growth models. For example, besides analyzing external debt sustainability and net interest payments, the survey captures the effects of remittances on the balance of payments constrained growth rate. Moreover, unlike the reviews associated with demand growth and technological catch-up (Romero 2015), this chapter surveys the rich literature that endogenizes non-price competitiveness or the ratio of foreign trade elasticities in balance of payments constrained growth models. It demonstrates how distribution, the National System of Innovation, Kaldor-Verdoorn and Schumpeterian technological change can alter the trade elasticities and the balance of payments constrained growth rate.

Chapter 2 of the dissertation formalizes a new channel through which capital flows can have ambiguous effects on the rates of growth of aggregate demand and the balance of payments constraint and thus, the evolution of the technological gap through Kaldor-Verdoorn effects (Kaldor 1966; Verdoorn 1949). The chapter shows that when a technological gap exits between two countries that share a common currency, capital flows toward the technological laggard can deteriorate its production structure and produce lower productivity growth. In other words, capital flows can engender a divergence in relative unit labour cost. As the laggard economy loses cost competitiveness, it simultaneously produces a lower balance of payments constrained growth rate. Other works within the balance of payments constrained growth framework do emphasize the growth-reducing effects of capital inflows but these works focus on the debt and foreign currency crises channels (Filho et al. 2013; Vera 2006; Curado and Porcile 2002). These results are driven by a crucial assumption—that the technological gap between the laggard and frontier economy exceeds the threshold that maximizes technological spillovers. It follows that the size of the initial technological gap matters for regional cohesion and the growth and technology effects of capital flows. The key implication here is that members or potential members of an Economic and Monetary Union (EMU) must pass the litmus test of the maximum distance from the frontier country, lest divergence threatens regional solidarity. However, this is a highly restrictive condition for membership in regional groupings. As such, the chapter also presents results that demonstrate how technology policy in laggard economies can promote technological convergence and sustain community cohesion. This is finding supports recent calls for Regional Innovation Systems and Fiscal Unions at the level of regional groupings that fund public investment and industrial policies in peripheral countries (Reinert and Kattel 2019; Stockhammer et al. 2019; 2015; Botta 2014). The principal insight here is that regional cohesion and convergence are possible even when the initial technological gap is large, if the community establishes a Regional Innovation System to reduce technological asymmetries.

Chapter 3 presents a long-run balance of payments constrained growth model to demonstrate the relationship among endogenous technological change, income distribution and economic growth between countries in an EMU. In this chapter, non-price competitiveness is endogenously determined by technological change and income distribution (wage share). Faster technological change through an improvement in the laggard's National System of Innovation, by way of public investment, improves product quality and the income elasticity of its exports, while a more egalitarian distribution of income has ambiguous effects. On one hand, a higher wage share increases import demand for consumer goods and crowds out the share of capital imports. These in turn are necessary for capital accumulation and technology transfer, so that a higher wage share reduces technological change and thus, non-price competitiveness. On the other hand, lower inequality can improve workers' access to education and health care, which enhance their ability to emulate imported technologies, thereby, promoting technological change. When the negative effect of the wage share dominates, the laggard economy confronts a big tradeoff between lowering income inequality and advancing technological convergence and economic growth. It follows that differences in income distribution affect regional cohesion and should serve as a convergence criterion in addition to the initial size of the technological gap. The chapter produces several testable hypotheses. First, only the least developed economies can experience inclusive economic growth and second, beyond a threshold level, a tradeoff emerges. Third, the intensity of the tradeoff is higher for economies with initially higher income inequality. Fourth, EMUs without a fiscal union or adequate cohesion/technology policies, will experience technological polarization and its accompanying crises. It is left for future work to empirically verify these propositions.

Chapter 4 looks at the question of how an exit from an EMU affects economic performance. It presents a three-period post-Kaleckian model with three sources of income (wages, profits and rents) to demonstrate the dynamic effects of a real devaluation. In the short-period, when prices and distribution are constant, contractionary effects relate to higher costs of imported capital goods and foreign interest payments. In the medium-run, prices, distribution and the loan rate are endogenous and uniquely related to the monetary economy. The latter is modeled as a regime of excess reserves, where bankers' liquidity preference for excess reserves and central bank bonds and loans become perfect substitutes at non-zero rates of interest. In the medium-term, a devaluation increases bankers' liquidity preference and contracts the supply of excess reserves through the sale of central bank securities, which increase the loan rate. An increase in the latter raises bankers' rent share and lowers the profit share, thus investment demand. Bankers' income also increases on account of a higher bond rate and larger holdings of central bank securities. Additionally, a devaluation increases banks' profitability of foreign assets in local currency. These medium-run responses lower the rates of capacity utilization and capital accumulation. In the long-period, the rate of technological progress is determined by retained earnings (profit share) and the cost of bank finance (loan rate). Given the medium-run findings, a devaluation lowers the rate of technological progress and by extension, the long-run rates of capacity utilization and accumulation. The implication of these dynamic contractionary effects is that the rate of net exports increases, in other words, a regime of domestic demand stagnation co-exists with improvements in the external balance. The central policy insight of the chapter is that the decision to exit currency unions, undertake a real devaluation or adopt flexible exchange rate regimes, must be based on sound assessments of the particular country's context. The established literature highlights several conditional factors that determine the effects of a devaluation: price elasticities, degree of factor substitutability, demand regimes, degree of import penetration, extent of excess capacity and foreign liabilities. This work demonstrates that prospective devaluers must also consider the degree of competition in their banking sector, size of bankers' foreign assets- and loan-capital ratios and whether or not their economy is in a regime of excess reserves.

Chapter 1

Balance of Payments Constrained Growth Models: A Structured Survey

1.1 Introduction

Since the global and Eurozone financial crises have erupted and discourses on protectionism have taken centre stage in the political and economic debates, there has been renewed interest in how the balance of payments affect growth, distribution and technological change. Of particular interest, are income disparities at both the world and regional levels. The European Economic and Monetary Union has promoted divergence rather than community cohesion and a similar story holds for the effects of globalization (Stockhammer et al. 2015; Milanovic 2016). Since Kaldor (1970)'s famous lecture on the *Regional Problem*—different regions growing at uneven rates, some forging ahead and others being left behind—open economy demand driven growth models have emerged to analyze the Regional Problem. Two decades prior to Kaldor's famous lecture, early development theorists have brought into sharper focus the roles of external demand, balance of payments and production structures in explaining what can be called the *Global Problem* (Prebisch 1959; 1950; Seers 1962). The latter can be understood as the global analogy to Kaldor's regional problem. Building on these foundations, Thirlwall (1979) has provided the workhorse open economy demand driven growth model. The aim of this chapter is to present a structured survey of the balance of payments (BP) constrained growth model, starting from its historical origins to present day.

Unlike other surveys (Ribeiro 2015; Thirlwall 2011; McCombie 2011), this chapter reviews the various mechanisms of relative price adjustments and undertakes a comprehensive review of capital flows in balance of payments constrained growth models. For example, besides analyzing external debt sustainability and net interest payments, the survey captures the effects of remittances on the balance of payments constrained growth rate. Moreover, unlike the reviews associated with demand growth and technological catch-up (Romero 2015), this chapter surveys the rich literature that endogenizes non-price competitiveness or the ratio of foreign trade elasticities in BP models. It demonstrates how distribution, the National System of Innovation, Kaldor-Verdoorn and Schumpeterian technological change can alter the trade elasticities and the balance of payments constrained growth rate.

In his seminal article, Thirlwall (1979) formally demonstrates that long-run growth can be balance of payments constrained. In other words, given the necessity of BP equilibrium in the long-run, output growth is constrained to grow no faster than the product of the trade elasticities and the rate of growth of external demand. Economic growth is demand not supply constrained. According to Thirlwall, the trade elasticities are deep structural parameters that reflect non-price competitive factors like technological capabilities, economic diversification and consumption patterns. This implies that structural change and production diversification can increase these trade elasticities and accelerate the long-run rate of growth consistent with BP equilibrium. In this seminal contribution, Thirlwall rules out any long-run effects of currency devaluations and confine their effects to the short- and medium-runs.

This workhorse model has since been extended several measures over to capture more complexities, so that the model can better fit the empirical data. For example, Thirlwall and Hussain (1982) extend the model to account for capital inflows since these can accelerate economic growth faster than that predicted by the original formulation. However, they fail to impose any restriction on capital inflows. It is implausible to assume that a given economy can indefinitely finance its current account deficit by way of accumulating ever rising external debt. Several extensions impose various forms of restrictions: a constant ratio of external debt to domestic income, imports, exports and also a constant rate of growth of capital inflows (Eliiott and Rhodd 1999; Barbosa-Filho 2001; Moreno-Brid 2003; Vera 2006; Alleyne and Francis 2008). Other extensions endogenize long-run growth and ergo, the ratio of foreign trade elasticities. One interesting finding in these extensions is that they resurrect the effectiveness of devaluations for long-term growth. In this class of models, currency devaluations affect the distribution of income in a two-class model of capitalists and workers. Specifically, devaluations reduce the wage share and increase firm-level profits, which are then invested in R&D, thereby, increasing the quality of commodities exported and the long-run rate of growth (Missio et al. 2017; Ribeiro et al. 2016; Missio and Jayme 2012; Fiorillo 2001). Some formulations impose a non-linear relationship between distribution and technological change, thus, producing ambiguous results for the relationship between a real devaluation and long-run output growth (Ribeiro et al. 2016).

The remainder of the chapter is organized as follows. Section 1.2 outlines the historical origins of the balance of the balance of payments constrained growth model and section section 1.3 presents the BP model along with its various extensions. Finally, section 1.4 concludes.

1.2 Precursors

1.2.1 The Laws of International Exchange

In his book, *England's Treasure by Foreign Trade* in 1664, Thomas Mun outlines the doctrine of Mercantilism. He explains that countries can become rich by accumulating precious metals (gold) through trade surpluses, which keep the rate of interest low and stimulate investment. In 1752, David Hume launches an attack on the doctrine of Mercantilism by way of two influential essays, *Of Money* and *Of the Balance of Trade*. Hume argues that the accumulation of precious metals only increases the price level without any real economy effects. In other words, contrary to Mercantilists, trade surpluses have no effect on the rate of interest and thereby, do not stimulate investment and economic growth. Herein lies the origin of the Quantity Theory of Money, the idea of money neutrality and the classical dichotomy of separating the real and monetary economy (Thirlwall 2011).

Building on Hume's work, David Ricardo (1951) presents his theory of why nations engage in international trade, even if one country has an absolute advantage in the production of all commodities. Consider two countries, A and B, with absolute advantage and disadvantage in all commodities traded respectively. In this instance, the basis of trade is the absolute cost advantage of country A and as trade takes place, country A and B experience a trade surplus and deficit respectively. According to Ricardo, the surplus country experiences an inflow of gold bullion, while the deficit country loses gold to country A. Relying on the work of David Hume's specie flow mechanism, Ricardo explains that the inflow and outflow of gold bullion engender inflationary and deflationary tendencies in country A and B respectively, until the surplus country loses cost advantage in some commodities and country B gains in others. These price changes supposedly mirror differences in comparative costs or result in absolute advantage reversals that produce differences in comparative costs (Constantine 2014). Essentially, price changes are used as the adjustment mechanism that ensures balanced trade. A fundamental implication of the Law of Comparative Cost is that free trade is beneficial to all countries—

whether at the level of the world economy or a regional grouping—irrespective of the size of the technological gap between trading partners or a country's absolute cost disadvantage (Shaikh 1980).

Ricardo's theory of trade firmly establishes the neutrality of money and thus, assumes that resources are fully employed. Given this theoretical frame, Ricardo's theory implies that trade imbalances or balance of payments disequilibria are only temporary and inconsequential to the performance of the real economy. The doctrine of Mercantilism has been overthrown and each nation can engage in international trade for mutual benefit rather than trade with the aim of accumulating trade surpluses.

Almost a century later, John Maynard Keynes discovers the common wisdom during the Mercantilist period, that monetary factors can affect the real economy (investment) through changes in the rate of interest (Keynes 1936: ch. 13, 23). Harrod (1957) builds on Keynes (1936) and applies his insights to the open economy. He contends that capital flows between countries affect liquidity and the rate of interest rather than relative prices. It follows that a surplus country experiences a relative decline in its rate of interest as gold bullion or capital enters its economy. In turn, capital flows are *reversed* to the deficit country in search of higher rates of return, thereby, undermining the specie flow mechanism that balances trade in Ricardian theory. Accordingly, the Harrodian mechanism shows that free trade reflects competitive cost advantages and disadvantages *not negate them* (Shaikh 2014: pp. 55).

The debate between the Mercantilists and the Free Traders has come full circle. On one hand, Keynes, Harrod and the Mercantilists make the case that income (employment) adjusts to restore balance of payments equilibrium and ergo, external disequilibrium has significant real and macroeconomic effects. On the other hand, Hume and Ricardo argue that balance of payments disequilibrium is a temporary monetary phenomenon with no real economy effects. In its modern form, the debate rests on the effectiveness of income and price adjustments in restoring balance of payments equilibrium. Unlike the period of the gold standard where exchange rates were at a fixed parity to gold, in the modern context, price adjustments are through flexible wages and exchange rates. Proponents of the price adjustment mechanism call for currency devaluations (in the case of external deficits) or a complete adoption of flexible exchange rate regimes that facilitate faster and more effective changes in relative prices. In the case of a regional grouping, say a currency union or an Economic and Monetary Union, where the exchange rate is essentially fixed for member countries, proponents of the price adjustment mechanism call for internal devaluations (Stockhammer et al. 2015).

The latter includes the reduction of labour's bargaining power through lower minimum wages and lower employment protection etc. The key idea is that lower bargaining power engenders lower wage demand, which allows the price mechanism to adjust external disequilibrium. Further, regional groupings, particularly those with a common currency, strongly advocate for the free mobility of labour, so that balance of payments disequilibrium between member states can be corrected through the labour market (price mechanism). For example, Mundell (1961) explains that countries in a currency union lose the price adjustment mechanism that balances trade when wages and prices are rigid. In his view, factor (labour) mobility is the only reliable adjustment mechanism.

In addition to the historical evidence[1] against the price mechanism as a means to balance trade, a number of theoretical models have emerged to demonstrate the real economy effects of balance of payments. The author discusses these in turn.

1.2.2 Harrod's Foreign Trade Multiplier

In his critique of balance of payments adjustments through relative price movements, Harrod (1957) indicates that the price adjustment mechanism is premised on the dual assumptions of full employment and that the price level is determined by the quantity of money. As explained earlier, based on Keynesian theory, changes in the quantity of money alter the rate of interest, induce a reversal in capital flows and undermine the necessary price movements that adjust the balance of payments.

To present a formal treatment of Harrod's ideas, the author follows McCombie and Thirlwall (1997) and (Ribeiro 2015: pp. 23). Assume that there are constant terms of trade in a given economy, with no government, savings and investment. It follows that income is generated from the production of consumer goods (C) and exports (X) as shown below.

$$Y = C + X \tag{1.1a}$$

Correspondingly, all income is spent on C and imports (M).

$$Y = C + M \tag{1.1b}$$

[1]See Cooper (1982), McCloskey and Zecher (1976) and Triffin (1964) for historical evidence that balance of payments have adjusted through changes in expenditure rather than relative prices during the period of the gold standard.

Let $M = M_0 + \mu Y$, where M_0 and μ are autonomous imports and the marginal propensity to import respectively. Given the restriction that trade is always balanced $(X = M)$, aggregate expenditure is given by:

$$Y = \frac{X - M_0}{\mu} \tag{1.1c}$$

Equation (1.1c) demonstrates the principle of the foreign trade multiplier, where $1/\mu$ is the multiplier.

$$\frac{\partial Y}{\partial (X - M_0)} = \frac{1}{\mu}$$

Should the hypothetical economy experience a trade surplus, its level of income and expenditure increase to restore balanced trade. As income expands, expenditure increases on both domestic and imported goods until external balance is restored. Conversely, an initial trade deficit engenders a contraction in both income and expenditure and thus, lowers expenditure on imports to restore external equilibrium. Based on Harrod's foreign trade multiplier, the inflow and outflow of gold bullion or capital flows generally, affect the level of income or employment rather than prices. Moreover, his analytical contribution also indicates that the level of income in some countries *expand*, while others *contract* to achieve balanced trade.

Hicks (1950)'s super-multiplier is an important extension of Harrod's foreign trade multiplier. The key idea is that there is only a partial direct effect of an increase in exports on national income through the foreign trade multiplier. It follows that external equilibrium depends on a super-multiplier that provides for a complete effect on national income as exports expand. To see this more clearly, consider the following extensions to Harrod's foreign trade multiplier with constant relative prices.

The standard Keynesian model can be described by Equations (1.2a)-(1.2g), where Y, C, I, G, X, M and T are aggregate income, consumption, investment, government spending, exports, imports and tax revenue respectively.

$$Y = C + I + G + X - M \tag{1.2a}$$

$$C = C_0 + c(Y - T) \tag{1.2b}$$

$$T = tY \tag{1.2c}$$

$$I = I_0 + bY \tag{1.2d}$$

$$G = G_0 \tag{1.2e}$$

$$X = X_0 \tag{1.2f}$$

$$M = M_0 + \mu Y \tag{1.2g}$$

After substitution, the level of income is given by:

$$Y = \frac{1}{k}\Big(C_0 + I_0 + G_0 + X_0 - M_0\Big) \tag{1.3}$$

The Keynesian multiplier k is defined as:

$$k = (1 - c - b + \mu + tc) \tag{1.4}$$

where c, b, μ and tc are marginal propensities to consume, invest, import and tax respectively. Note that $k = (1 - c - b + \mu + tc) > \mu$ so that the Hicks super-multiplier is greater than the Harrod foreign trade multiplier.

Equation (1.3) in growth rate form is shown below, where y, x and q are the growth in output, export and autonomous demand respectively and $\alpha = X/Y$.

$$y = \frac{1}{k}\Big(\alpha x + (1-\alpha)q\Big) \tag{1.5}$$

The growth in imports (m) induced by the growth in exports is given by:

$$m = \frac{\mu}{k}x \tag{1.6}$$

Since $k > \mu$, Equation (1.6) says that the growth in imports is less than the growth in exports, so that balanced trade trade is not obtained. Hicks contends that in the long-run, the growth in autonomous demand increases as export demand grows and this in turn increases expenditure on imports and restores balanced trade. Equations (1.7) and (1.8) show the foreign trade and super-multiplier respectively.

$$y = \frac{1}{\mu}\alpha x \tag{1.7}$$

$$y = \frac{1}{k}\Big(\alpha x + (1-\alpha)q\Big) \tag{1.8}$$

Hicks introduced the idea that investments can be induced by increases in aggregate income, which implies that expenditure can increase beyond that indicated by the foreign trade multiplier. Alternatively, tax revenues grow as income increases and this can produce a fiscal surplus given autonomous government expenditure. Assuming that a balanced budget is required, balanced trade can be obtained through fiscal expansion as x increases. In short, the Hicks super-multiplier ensures that autonomous demand adjusts to achieve balanced trade as export demand accelerates.

1.2.3 Raul Prebisch

In two seminal papers, Prebisch shows that the allocative efficiency gains from free trade may be negated by the underutilization of resources, when foreign exchange is the dominant constraint on output (Prebisch 1959; 1950). Prebisch (1959) demonstrates the problem with a numerical example. He assumes that the less developed country (LDC) exports only primary commodities with an average income elasticity of export demand (ϵ_{LDC}) of say, $\epsilon_{LDC} = 0.8$. Further, Prebisch assumes that the developed country (DC) exports only manufactured goods, which have a higher income elasticity of export demand, $\epsilon_{DC} = 1.3$. It follows that the income elasticities of import demand for the LDC and DC are $\pi_{LDC} = 1.3$ and $\pi_{DC} = 0.8$ respectively. If both countries grow at the same rate, say 5 percent, it becomes clear that a persistent external imbalance emerges. In the case of the LDC, its imports grow at the rate of 5*1.3 = 6.5 percent and export growth is given by 5*0.8 = 4 percent. It follows that the LDC accumulates external deficits if it grows at the same rate as the DC. Since external disequilibrium cannot be sustained indefinitely, Prebisch contends that the LDC must contract its rate of economic growth. Specifically, given the DC's rate of growth of 5 percent, the LDC's rate of economic growth consistent with balance of payments equilibrium is given by:

$$y_{LDC} = \frac{(0.05)(0.8)}{1.3} = 3.1 \tag{1.9}$$

or, the LDC is constrained to grow at only 62 percent of the growth of the DC:

$$\frac{y_{LDC}}{y_{DC}} = \frac{0.8}{1.3} = 0.62 \tag{1.10}$$

Prebisch's central conclusion is that free trade between countries with different production structures, as proxied by differences in their income elasticities of demand for exports and imports, inevitably produces divergence in economic performance to maintain balanced trade. Thirlwall (2011) acknowledges that Prebisch (1959) is the closest formulation to his balance of payments constrained growth model and credits Prebisch as the first to formalize growth as constrained by the balance of payments.

1.2.4 Seers' Model

Seers (1962) presents a centre-periphery model to analyze economic performance between manufacturing and primary commodity exporters under the condition of balanced trade. As such, Seers' model is similar to Harrod (1957) and Prebisch (1959) in that he assumes balanced trade, constant terms of trade and different export structures in the centre (c) and periphery (p).

Consider Seers' linear import functions for the centre (m_c) and periphery (m_p):

$$m_c = A_c + B_c y_c \tag{1.11a}$$

$$m_p = A_p + B_p y_p \tag{1.11b}$$

and under the condition of balanced trade $(m_c = m_p)$, income growth in the periphery is given as follows.

$$y_p = \frac{A_c - A_p + B_c y_c}{B_p} \tag{1.11c}$$

Therefore, relative income growth is derived as shown below.

$$\frac{y_p}{y_c} = \frac{A_c - A_p}{B_p y_c} + \frac{B_c}{B_p} \tag{1.11d}$$

Seers assumes that income grows exponentially in the centre country $(y_{c0} e^{rt})$ and after substitution into Equation (1.11d), relative income growth becomes:

$$\frac{y_p}{y_c} = \frac{A_c - A_p}{B_p y_{c0} e^{rt}} + \frac{B_c}{B_p} \tag{1.11e}$$

Differentiating with respect to time:

$$\frac{d(y_p/y_c)}{dt} = \frac{-r(A_c - A_p)}{B_p y_{c0} e^{rt}} \tag{1.11f}$$

Equation (1.11f) shows how relative rates of economic growth evolve through time and when $A_c > A_p$, balanced trade between centre and periphery requires that the periphery becomes relatively poorer. This insight is similar to Harrod (1957) and Prebisch (1959), where the level of income or rate of economic growth adjust to maintain balanced trade. Seers and Prebisch are more specific in that they show that it is the periphery—the economy that exports agricultural commodities—that experiences lower economic growth. Why should $A_c > A_p$? If the income elasticity of demand for imports in the periphery exceed unity, then A_p must be negative and if the income elasticity of demand for imports in the centre is less than unity, then A_c is positive (Seers 1962; Thirlwall 1983). Recall from Prebisch (1959) that the LDC or the periphery has a higher income elasticity of import demand and this implies that $A_c > A_p$. Therefore, relative incomes diverge under the condition of balanced trade.

1.2.5 Kaldorian Export-led Growth Model

In 1970, Nicholas Kaldor delivers a speech to the Scottish Economic Society and outlines a narrative model of what he calls the regional problem—different regions growing at uneven rates—some forging ahead and others being left behind (Kaldor 1970). Central to Kaldor's thesis is Myrdal (1957)'s idea of circular and cumulative causation (CCC). Kaldor explains that the concept of CCC is simply increasing returns to scale, related to large scale industrial production, skills development, creation and diffusion of ideas and the growth of industry. According to Kaldor, when trade is opened up between two countries, the one that is more developed industrially gains at the expense of the less developed country. This is the idea of centre-periphery divergence under conditions of balanced trade.

The cumulative causation approach views growth as based on two elements:

- A causal link between demand growth and growth in production
- A causal link between demand growth and productivity growth.

The key mechanisms are as follows. Rapid export growth leads to faster output growth through increased utilization rates and stimuli to investment, which in turn increases productivity growth through induced technical change—learning by doing (Arrow 1962). As productivity growth accelerates, international price competitiveness is enhanced and by extension, export demand, reinforcing the cumulative causation growth process. This literature finds consensus that the nexus between demand and productivity growth is explained by returns to scale, specialization and market size, induced technical change and learning by doing (Boyer and Petit 1989; Kaldor 1981; Lawson et al. 1989; McCombie and Spreafico 2016). Verdoorn (1949) is the first to formalize the idea that there is a causal link between output growth and productivity growth and after Kaldor (1966) discovers empirical support for this claim, he later restates this thesis as a Law. The literature now identifies the well documented statistical relationship[2] as Kaldor-Verdoorn's Law (McCombie et al. 2002).

Dixon and Thirlwall (1975) are the first to formalize Kaldor (1970)'s ideas. Consider the system of four equations that illustrates a two-country model with a common currency:

$$y = \gamma x \tag{1.12a}$$

$$x = \rho p_d + \delta p_f + \beta z \tag{1.12b}$$

$$p = \tau + w - \hat{a} \tag{1.12c}$$

$$\hat{a} = a_0 + \lambda y \tag{1.12d}$$

where y is the rate of output growth; x is the rate of export growth and $\gamma > 0$ is the constant elasticity of output growth with respect to export growth. The domestic and foreign inflation rate are given by p_d and p_f respectively. Moreover, the respective price and cross elasticities of export demand are $\rho < 0$ and $\delta > 0$; β is the income elasticity of exports; z is the growth rate of foreign demand; w is nominal wage growth; τ is the growth of the mark-up factor; $\hat{a}$ is the growth of labour productivity; autonomous productivity growth is a_0 and $0 < \lambda < 1$ is the Kaldor-Verdoorn coefficient. After substitution, output growth is given by:

$$y = \frac{\gamma[\rho(w - a_0 + \tau) + \delta p_f + \beta z]}{1 + \gamma\rho\lambda} \tag{1.13}$$

The first point to note is that since $\rho < 0$, output growth is a positive function of a_0, λ, p_f, β and z but inversely related to w and τ. Second, if regional differences exist in the parameter values, the Kaldor-Verdoorn coefficient (λ) exaggerates these differences. Third, it is λ that presents the effects of CCC. For example, according to Dixon and Thirlwall (1975), should a country obtain an advantage in the production of industrial goods with a high β, this increases

[2]For empirical evidence of Kaldor-Verdoorn's Law see Romero and McCombie (2016a), Romero and Britto (2017), Millemaci and Ofria (2014), Angeriz et al. (2008), McCombie et al. (2002), Fingleton and McCombie (1998) and Leon-Ledesma (1999).

the rate of its output growth and through the Kaldor-Verdoorn effects produce cumulative rounds of uneven growth, what Kaldor calls the regional problem. Third, Dixon and Thirlwall (1975) explain that differences in industrial composition between countries determine the size of λ, so that regional inequality is a function of differences in production structures. In terms of policy, Dixon and Thirlwall recommends regional intervention by way of identifying economic activities with a high β and encouraging their production in depressed regions through capital and labour incentives. Fourth, Dixon and Thirlwall are careful to emphasize that any exogenous shock to a country's rate of economic growth is not sufficient to produce sustained uneven growth, unless the shock affects the parameters of the model. In the absence of this, the economy's rate of growth simply converges back to its initial equilibrium growth rate.

To assess the adjustment process, Dixon and Thirlwall take into account a lagged export function:

$$x_t = \rho p_{d\,t-1} + \delta p_{f\,t-1} + \beta z_{t-1} \tag{1.14}$$

Combining Equation (1.14) with Equations (1.12a), (1.12c) and (1.12d) derives the lagged general solution, where A is the initial condition.

$$y_t = A(-\gamma\rho\lambda)^t + \frac{\gamma[\rho(w_{t-1} - a_0 + \tau_{t-1}) + \delta p_{f\,t-1} + \beta z_{t\,1-1}]}{1 + \gamma\rho\lambda} \tag{1.15}$$

Output growth now depends on the value of $\gamma\rho\lambda$ and since $\rho < 0$, it follows that $-\gamma\rho\lambda > 0$. This implies that the condition for cumulative divergence is given by $-\gamma\rho\lambda > 1$, which Dixon and Thirlwall rules out given realistic parameter values. They conclude that divergence is only possible if the parameter values continually change through time, which continually changes in the equilibrium rate of growth. For example, the price and income elasticities of demand can change through time as the structure of production changes and these engender different or uneven equilibrium growth rates.

The models associated with the works of Harrod, Prebisch, Seers, Dixon and Thirlwall bring exports, foreign exchange and income to the forefront as it regards the debate on trade and balance of payments adjustments. In these models, it is changes in the level of income or economic growth that adjusts external disequilibrium and absent intervention, they imply that external equilibrium necessitates a persistent gap between rich and poor countries.

1.3 Balance of Payments Constrained Growth Model

Notwithstanding the fundamental role of export growth to demand growth and induced technical change through the Kaldor-Verdoorn effect, Thirlwall (1979) contends that economic growth is ultimately balance of payments (BP) constrained. He notes that faster output growth can increase import demand and consequently, constrain the effectiveness of cumulative growth. To derive the balance of payments constrained growth rate (y_{BP}), Thirlwall defines the balance of payments identity as follows, where P_d, X, P_f, M and E are the domestic price level, export demand, foreign price level, import demand and nominal exchange rate respectively.

$$P_d X = P_f M E \tag{1.16}$$

In growth rate form, the condition for balance of payments equilibrium is given below, where lower cases indicate rates of change.

$$p_d + x = p_f + m + e \tag{1.17}$$

The export demand function is given by Equation (1.18), where Z represents income in the foreign country. The parameters $\alpha < 0$ and $\beta > 0$ are the price and income elasticities of export demand respectively.

$$X = \left(\frac{P_d}{P_f E}\right)^{\alpha} Z^{\beta} \tag{1.18}$$

In growth rate form:

$$x = \alpha(p_d - p_f - e) + \beta z \tag{1.19}$$

Import demand assumes the following specification, where the parameters $\gamma < 0$ and $\varepsilon > 0$ are the price and income elasticities of import demand respectively. The parameter Y represents the level of income in the domestic economy.

$$M = \left(\frac{P_f E}{P_d}\right)^{\gamma} Y^{\varepsilon} \tag{1.20}$$

In growth rate form:

$$m = \gamma(p_f + e - p_d) + \varepsilon y \tag{1.21}$$

After substitution of Equations (1.19) and (1.21) into (1.17), Thirlwall derives the rate of growth of the domestic economy consistent with balance of payments equilibrium (y_{BP}).

$$y_{BP} = \frac{\beta z + (1 + \alpha + \gamma)(p_d - p_f - e)}{\varepsilon} \tag{1.22}$$

The following propositions follow from Equation (1.22):

- A faster growth of foreign income (z) and a higher β raise y_{BP}.
- A higer income elasticity of demand for imports (ε) lowers y_{BP}.
- A devaluation or currency depreciation ($e > 0$) increases y_{BP}, if the Marshall-Lerner conditions holds, i.e. $|\alpha + \gamma| > 1$. Thirlwall adds the qualification that a devaluation cannot permanently increase the balance of payments constrained growth rate, since after a devaluation, $e = 0$ holds. A devaluation can only increase the equilibrium growth rate if it favourably affects the parameters of the model.
- Higher rates of inflation in the domestic economy reduce the balance of payments constrained growth rate if $|\alpha + \gamma| > 1$.

Further, if relative prices measured in a common currency do not change in the long-run, the balance of payments constrained growth rate becomes Thirlwall's Law:

$$y_{BP} = \frac{\beta z}{\varepsilon} \tag{1.23}$$

Equation (1.23) explains that a country's rate of economic growth consistent with balance of payment equilibrium, is a positive function of the growth of foreign demand and non-price competitive factors—the ratio of foreign trade elasticites (β/ε). Note the striking similarity between Thirlwall's Law and the works of Harrod, Prebisch, Seers and Dixon and Thirlwall that emphasize foreign demand and trade elasticities. Unlike the work of Dixon and Thirlwall (1975), the balance of payments constrained growth model has an import demand function and is absent of cumulative causation. Moreover, unlike Seers (1962), the BP model includes both export and import demand functions and no assumption regarding the growth of external demand is imposed. Thirlwall's Law is closer to Harrod's foreign trade multiplier but in a dynamic context. To see this more clearly, the author rewrites Thirlwall's Law. At constant terms of trade in the long-run, $\beta z = x$ per Equation (1.19) and after re-substitution yields:

$$y_{BP} = \frac{x}{\varepsilon} \tag{1.24}$$

Equation (1.24) is the dynamic version of Harrod's foreign trade multiplier. Recall the trade multiplier as:

$$Y = \frac{X}{\mu}$$

which can be written as:

$$\Delta Y = \frac{\Delta X}{\mu}$$

or,

$$\Delta Y = \Delta X / (\Delta M / \Delta Y) \tag{1.25}$$

Multiplying the left-hand side of Equation (1.25) by X/Y and the right-hand side by M/Y derives:

$$\Delta Y / Y = (\Delta X / X) / [(\Delta M / M) / (\Delta Y / Y)] \tag{1.26}$$

By definition, Equation (1.26) is equivalent to Equation (1.24):

$$y_{BP} = \Delta Y / Y = (\Delta X / X) / [(\Delta M / M) / (\Delta Y / Y)] = \frac{x}{\varepsilon} \tag{1.27}$$

1.3.1 Elasticity Pessimism

Thirlwall and Dixon (1979) attempt to reconcile their earlier work of export-led growth (Dixon and Thirlwall 1975) with the balance of payments constraint growth model developed by Thirlwall (1979). Equation (1.28a) shows the export-led growth model with cumulative causation developed by Dixon and Thirlwall (DT), while Equation (1.28b) illustrates the balance of payments constrained growth model, where the subscript T represents Thirlwall.

$$y_{DT} = \frac{\gamma[\rho(w - a_0 + \tau) + \delta p_f + \beta z]}{1 + \gamma\rho\lambda} \tag{1.28a}$$

$$y_T = \frac{\beta z + (1 + \alpha + \gamma)(p_d - p_f - e)}{\varepsilon} \tag{1.28b}$$

To derive Thirlwall and Dixon (1979)'s reconciliation, substitute Equations (1.12c) and (1.12d) into Equation (1.28b), where the subscript TD means Thirlwall and Dixon.

$$y_{TD} = \frac{\beta z + (1 + \alpha + \gamma)(w - a_0 + \tau - p_f - e)}{\varepsilon + \lambda(1 + \alpha + \gamma)} \tag{1.29}$$

Equation (1.29) captures the balance of payments constraint and cumulative causation, which demonstrates that both price and non-price competitiveness affect economic growth. However, as noted by Ribeiro et al. (2017b), there is no explicit mechanism that ensures the convergence of relative prices and output growth towards their respective equilibrium values. Only when the assumption of cumulative causation is dropped, do the predicted rates of growth and prices coincide with their long-run values. To see this clearly, assume that the Marshall-Lerner condition does not hold ($1 + \alpha + \gamma = 0$), which collapses Equation (1.29) into Thirlwall's Law ($y_{BP} = \beta z / \varepsilon$). This assumption best illustrates the elasticity pessimism in balance of payments constrained growth models. Proponents of export-led growth models stress the value of changes in relative cost competitiveness, driven by endogenous technological change as the source of export success. However, scholars in the tradition of BP models contend that such changes dissipate in the long-run (elasticity pessimism). Therefore, Thirlwall's law is viewed as the long-run equilibrium growth rate, while Equation (1.29) and other variants that include price effects are understood as medium-run models.

1.3.2 Relative Price Adjustments

Due to the elasticity pessimism, only a handful of scholars consider relative price adjustments in balance of payments constrained growth models (Ribeiro et al. 2017b; Porcile and Lima 2010; Pugno 1998).

1.3.2.1 Labour Market Institutions

Ribeiro et al. (2017b) model the mechanisms by which Thirlwall and Dixon (1979)'s growth rate coincides with Thirlwall's Law without the restrictive assumption that the Marshall-Lerner condition does not hold. To do so, they extend Thirlwall and Dixon (1979)'s model in two ways. First, they include imported intermediate inputs into the prime cost of domestic firms and second, they model the determination of wages as conflicting income claims between workers and capitalists.

Consider their mark-up pricing Equation, where T is the firm's mark-up factor, W/a is nominal unit labour cost and $P_f E\mu$ is the unit imported intermediate inputs cost in domestic currency.

$$P_d = T\left(\frac{W}{a} + P_f E\mu\right) \tag{1.30}$$

In growth rate form, domestic inflation evolves as follows, where lower cases indicate rates of change and $\varphi \in (0,1)$.

$$p_d = \tau + \varphi(w - \hat{a}) + (1-\varphi)(p_f + e) \tag{1.31}$$

The share of unit labour cost in total prime costs is given by $\varphi = (W/a)/[(W/a)+P_f E\mu]$ and is directly related to the bargaining power of workers but inversely related to the proportion of imported raw materials in firm's unit variable cost. The first point to note about Equation (1.31) is that a currency devaluation ($e > 0$) increases the rate of change of the unit imported intermediate input cost and then feeds its way to domestic prices with a lag. Second, depending on relative bargaining power between workers and capitalists, the rate of change of money wage increases with a lag to match the higher costs of imported raw materials. This in turn increases the rate of domestic inflation until real wage growth equals productivity growth ($w - p_d = \hat{a}$). Third, a currency devaluation improves the market share of domestic goods as the costs of imported goods increase, which raises the mark-up factor and domestic prices.

Nominal wage growth adjusts to changes in relative prices in the short-run as shown below, when $t_0 < t < t^*$.

$$w = w_0 \tag{1.32}$$

It is assumed that there is strong nominal wage rigidity in the short-period, so that wage growth is constant in the short-run. However, in the long-run when $t > t^*$, the wage bargaining process begins and nominal wages grow as follows:

$$w = p_d + \eta \hat{a} \tag{1.33}$$

where $\eta = 1-(1/k)(\varphi^e - \varphi)$, $k > 0$ is an adjustment parameter and φ^e is workers' expected long-run wage share. The stronger the bargaining power of workers, the closer is η to unity, which implies that workers are able to incorporate the gains of productivity growth into faster nominal wage growth. Moreover, in the long-run, when the actual share of unit labour cost approaches workers' expected share ($\varphi \to \varphi^e$), the adjustment parameter approaches unity ($\eta \to 1$) and growth in real wages matches productivity growth ($w - p_d = \hat{a}$).

Since a currency devaluation increases the market share of domestic goods and the mark-up factor, T can be endogenized as follows:

$$T = \delta\left(\frac{EP_f}{P_d}\right) = \delta\left[\frac{EP_f}{T(W/a + P_f E\mu)}\right] \tag{1.34}$$

where $\delta > 0$ is an adjustment parameter. In rate of change:[3]

$$\tau = -(\varphi/2)[w - \hat{a} - (p_f + e)] \tag{1.35}$$

Equation (1.35) says that a currency devaluation ($e > 0$) increases the rate of change of the mark-up factor.

Substitution of Equations (1.35) and (1.32) into Equation (1.31) derives the short-run domestic inflation rate:

$$p_d = (\varphi/2)(w - \hat{a}) + (1 - \varphi/2)(p_f + e) \tag{1.36}$$

In turn, the substitution of Equations (1.35) and (1.33) into Equation (1.31) derives the long-run domestic inflation rate:

$$p_d = [(\eta - 1)\hat{a}/(1 - \varphi/2] + p_f + e \tag{1.37}$$

Recall that in the long-run $\eta = 1$, so that $p_d = p_f + e$, which implies that relative prices are constant in the long-run. In other words, as the actual share of unit labour cost matches

[3]See Ribeiro et al. (2017b) Appendix 4 for proof.

workers' expected share ($\varphi \to \varphi^e \Rightarrow \eta \to 1$), relative prices do not change. The novelty in Ribeiro et al. (2017b)'s formulation is that the stronger the bargaining power of workers, the faster relative prices adjust to their long-run equilibrium level.

Given the derivation of the short- and long-run domestic inflation rates, it is simple to derive the short- and long-run balance of payments constrained growth model. Ribeiro et al. (2017b) present the following extended balance of payments identity to account for the disaggregation of imports into imported intermediate inputs (M^i) and imported consumer goods (M^c). For simplicity, it is assumed that $P_f = P_f^i$.

$$P_d X = E(P_f M^c + P_f^i M^i) \tag{1.38}$$

In rates of change:

$$p_d + x = e + p_f + \theta m^c + (1-\theta) m^i \tag{1.39}$$

where $\theta = M^c/M$ and $(1-\theta) = M^i/M$. Export demand growth assumes the familiar form:

$$x = \alpha(p_d - p_f - e) + \beta z \tag{1.40}$$

Their import demand functions in growth rate form are shown below:

$$m = \gamma(p_f + e - p_d) + \varepsilon_c y \tag{1.41a}$$

$$m^i = y \tag{1.41b}$$

where ε_c is the income elasticity of demand for imported consumer goods. Equation (1.41b) says that the demand for imported intermediate inputs is directly related to output growth.

Substitution of Equations (1.41a), (1.41b) and (1.40) into Equation (1.39) derives the balance of payments constrained growth model, where $\varepsilon = \theta\varepsilon_c + (1-\theta)$. This implies that the income elasticity of import demand is a weighted average of the income elasticities of demand for imported consumer goods and intermediate inputs. In Ribeiro et al. (2017b)'s set-up, the growth of labour productivity in constant in the short-run, so that the short-run model omits cumulative causation.

$$y = \frac{\beta z + (1 + \alpha + \theta\gamma)(p_d - p_f - e)}{\varepsilon} \tag{1.42}$$

Substitution of Equation (1.36)—the short-run domestic inflation rate—into Equation (1.42) derives Ribeiro et al. (2017b)'s short-run (SR) balance of payments constrained growth model.

$$y_{SR} = \frac{\beta z + (1+\alpha+\theta\gamma)(\varphi/2)(w_0 - \hat{a} - p_f - e)}{\varepsilon} \tag{1.43}$$

To derive their long-run balance of payments constrained growth model, recall that productivity growth is given by:

$$\hat{a} = a_0 + \lambda y \tag{1.44}$$

Substitution of Equation (1.44) into the long-run domestic inflation rate—Equation (1.37)—and its corresponding solution into Equation (1.42), derives Ribeiro et al. (2017b)'s long-run (LR) balance of payments constrained growth model.

$$y_{LR} = \frac{(1-\varphi/2)\beta z + (1+\alpha+\theta\gamma)(\eta-1)a_0}{(1-\varphi/2)\varepsilon - (1+\alpha+\theta\gamma)(\eta-1)\lambda} \tag{1.45}$$

Recall that in the long-run $\eta = 1$, which collapses Equation (1.45) into Thirlwall's Law ($y_{BP} = \beta z/\varepsilon$) without the assumption that the Marshall-Lerner condition does not hold ($1 + \alpha + \theta\gamma = 0$), unlike Thirlwall and Dixon (1979).

1.3.2.2 Labour Market Adjustments

Other formulations of relative price adjustments in balance of payments constrained growth models place greater emphasis on the dynamics of the labour market rather than labour market institutions as in Ribeiro et al. (2017b). For example, Pugno (1998) extends Thirlwall (1979)'s model to demonstrate how wages adjust to changes in relative prices. Pugno endogenizes wage growth as a positive function of employment growth, so that a tighter labour market increases nominal wage growth. Pugno shows that any gains of enhanced price competitiveness, say through a currency devaluation, accelerates short-run economic growth. This in turn increases employment growth and boosts nominal wage growth, which reduces the price competitiveness of domestic firms. It follows that changes in relative prices are constant in the long-run due to labour market adjustments. Porcile and Lima (2010) provide an interesting extension to Pugno's model and endogenize the labour supply as a positive function of the wage gap between the modern and the subsistence sector. In their dual economy macrodynamic model, the higher the elasticity of labour supply, the more responsive are workers in the subsistence sector to the wage gap. For example, a marginal increase in the modern sector wage rate generates an inflow of subsistence labour toward the modern sector and eliminates the wage gap. It follows that the short-run change in relative prices are eliminated in the long-run when the labour supply responds so quickly to the wage gap that relative prices remain constant.[4]

In the works of Pugno and Porcile and Lima, relative price adjustment is exclusively a phenomenon of the labour market, i.e. movements in the demand and supply of labour. But as neatly demonstrated by Ribeiro et al. (2017b), price adjustments can take place independently of the labour market, so as long as labour market institutions—labour unions—have sufficient bargaining power to influence wage growth. The principal insight here is that Thirlwall's Law can be observed even when there is slack in the labour market.

1.3.2.3 Capital Flows and Trade Barriers

Garcimartin et al. (2010) incorporate relative prices and capital flows in a balance of payments constrained growth model and present an alternative channel by which relative prices approach their long-run equilibrium values. Consider their system of Equations where the overdot indicates time derivative. Variables Y, X, M are incomes, exports and imports respectively; export and import prices are XP and MP; ER is the exchange rate; and Z_1, Z_2 are unrequited transfers and net capital inflows respectively. The parameter α is the speed of adjustment.

$$\dot{y} = \alpha_1(x + z_1 + xp - m - mp - er) + \gamma Z_2 \tag{1.46a}$$

$$\dot{x} = \alpha_2(x^e - x) \tag{1.46b}$$

$$\dot{m} = \alpha_3(m^e - m) \tag{1.46c}$$

$$\dot{Z}_2 = \alpha_4(K - Z_2) \tag{1.46d}$$

$$\dot{er} = \alpha_5(er^e - er) + \gamma_3 Z_2 \tag{1.46e}$$

[4] Porcile and Lima defend this theoretical formulation based on the empirical evidence that the natural rate of economic growth is endogenous to the actual rate of growth for 15 OECD countries (Leon-Ledesma and Thirlwall 2002; 2000) According to Porcile and Lima (2010), the labour supply is endogenous through several mechanisms: hours worked, labour participation rates—particularly among females—reallocation of labour from low to high productivity sectors and immigration.

Further, $x^e = a+\beta_1(xp-p^*-er)+\beta_2 y^*$, where the star (*) indicates variables for the foreign country. Similarly, $m^e = b+\beta_3(mp+er-p)+\beta_4 y$ and the equilibrium value of capital inflow is the constant K. According to Garcimartin et al. (2010), the expected exchange rate is given by:

$$er^e = PPP + \delta \tag{1.6}$$

where PPP is purchasing power parity and δ is a constant that captures the deviations from PPP due to non-tradable goods or trade barriers. Garcimartin et al. (2010) explain that capital flows may influence the speed of adjustment, e.g. if the exchange rate is above its equilibrium value, in the long-run it converges towards it, but this path can be mitigated, amplified, or even reversed by capital flows. The key ideas here are that changes in relative prices or short-run deviations of the exchange rate from PPP are mitigated over time by capital flows and lower trade barriers. Unlike the formulations associated with labour market institutions and adjustments, Thirlwall's Law can be observed as tariff and non-tariff barriers to trade are lowered. The principal story here is that the Law of One Price and PPP are more likely to hold under the condition of free trade.

After substitution, the steady-state rate of economic growth yields:[5]

$$\lambda_y = \frac{(\lambda_{xp}-\lambda_{mp})+\beta_1(\lambda_{xp}-\lambda_{p*}-\lambda_{PPP})+\beta_3(\lambda_p-\lambda_{mp}-\lambda_{PPP})+\lambda_{z1}+\beta_2\lambda_{y*}}{\beta_4} \tag{1.7}$$

where λ_i is the steady-state growth rate of variable i. When trade barriers are eliminated and net capital inflow assumes its constant value in the long-run, then Equation (1.7) collapses into Thirlwall's Law ($\lambda_y = \beta_2\lambda_{y*}/\beta_4$).

1.3.3 Capital Flows

Thirlwall and Hussain (1982) acknowledge that developing countries are able to attract capital inflows to fund ever-growing current account deficits. Under such circumstances, economic growth is no longer constrained by the balance of payments but by the rate of growth of capital inflows, which reduces the predictive power of Thirlwall's Law. As such, Thirlwall and Hussain amend the balance of payments constrained growth model to allow for capital inflows. The

[5] See Garcimartin et al. (2010) Appendix A for derivation.

balance of payments identity is given by:

$$P_d X + C = P_f M E \tag{1.8}$$

where $C > 0$ is net capital inflows. In growth rate form:

$$\theta(p_d + x) + (1-\theta)c = p_f + m \tag{1.9}$$

where $\theta = (XP_d)/(P_f ME)$ and $(1-\theta) = C/(P_f ME)$; $0 < \theta < 1$. In other words, θ and $(1-\theta)$ represent the share of imports funded by exports and capital inflows respectively. Recall that exports and imports grow as follows:

$$x = \alpha(p_d - p_f - e) + \beta z \tag{1.10a}$$

$$m = \gamma(p_f + e - p_d) + \varepsilon y \tag{1.10b}$$

and after substitution into Equation (1.9), the balance of payments constrained growth rate is given by:

$$y_{BP} = \frac{\theta\beta z + (1 + \theta\alpha + \gamma)(p_d - p_f - e) + (1-\theta)(c - p_d)}{\varepsilon} \tag{1.11}$$

where $c - p_d$ is the growth rate of real capital inflows. This is Thirlwall and Hussain (1982)'s result where growth can be disaggregated into four components:

- Real terms of trade effect $(p_d - p_f - e/\varepsilon)$
- Real terms of trade effect combined with the weighted price elasticities of exports and imports $(1 + \theta\alpha + \gamma)(p_d - p_f - e)/\varepsilon)$
- Weighted growth in foreign demand $(\theta\beta z/\varepsilon)$
- Weighted growth in real capital inflows $((1-\theta)(c - p_d)/\varepsilon)$.

If the assumption of constant relative prices are imposed, then Equation (1.11) reduces to:

$$y_{BP} = \frac{\theta\beta z + (1-\theta)(c - p_d)}{\varepsilon} \tag{1.12}$$

which demonstrates that a country's balance of payments constrained growth is the weighted sum of the growth of exports and the growth of real capital flows divided by the income elasticity of demand for imports. Note that if all imports are funded by export earnings (no capital inflows), then $\theta = 1$ and Equation (1.12) collapses into Thirlwall's Law ($y_{BP} = \beta z/\varepsilon$).

One important limitation of Thirlwall and Hussain (1982)'s model is that it imposes no restriction on the evolution of the current account deficit and ergo, fails to consider the long-run sustainability of external debt. In other words, the Thirlwall and Hussain model is useful for analyzing medium-run growth dynamics when an economy experiences economic growth, external deficits and capital inflows. But this medium-run growth trajectory is unlikely to be observed in the long-run since most economies cannot indefinitely accumulate external liabilities to fund their trade deficits. As external liabilities rise, financial uncertainty increases until $c = 0$ and $\theta = 1$, which impose Thirlwall's Law as the long-run trend.

Moreno-Brid (1998) extends the Thirlwall and Hussain model and imposes the restriction that the current account deficit must be a constant share of domestic income. This restriction allows for a sustainable accumulation of external debt rather than an explosion of foreign indebtedness as in the Thirlwall and Hussain model. Moreno-Brid's restriction can be formulated as follows:

$$\frac{P_d X - P_f M E}{P_d Y} = \frac{P_d C}{P_d Y} = \frac{C}{Y} = k \tag{1.13}$$

where $P_d Y$ is the restriction of nominal domestic income; C/Y is the ratio of capital inflows to income or the ratio of current account deficit to income, which is equivalent to the constant $k > 0$. This implies that:

$$c = y \tag{1.14}$$

which is necessary per the restriction k. Substitution of Equation (1.14) into (1.12) yields the balance of payments constrained growth rate consistent with a constant ratio of current account deficit to domestic income.

$$y_{BP} = \frac{\theta \beta z + (1 + \theta \alpha + \gamma)(p_d - p_f - e)}{\varepsilon - (1 - \theta)} \tag{1.15a}$$

Under the assumption of constant terms of trade in the long-run, Equation (1.15a) becomes:

$$y_{BP} = \frac{\theta \beta z}{\varepsilon - (1-\theta)} \tag{1.15b}$$

Equation (1.15b) says that the larger the current account deficit as a share of domestic income that the economy can sustain, the higher the balance of payments constrained growth rate. But Moreno-Brid (1998)'s model omits an important countervailing force associated with external liabilities, i.e. interest payment on debt. Several studies have incorporated debt servicing in balance of payments constrained growth models (Eliiott and Rhodd 1999; Barbosa-Filho 2001; Moreno-Brid 2003; Vera 2006; Alleyne and Francis 2008). To account for interest payment on debt, the balance of payments identity is revised as follows:

$$P_d X + C - R = P_f M E \tag{1.16}$$

where R represents net interest payments on external debt. In growth rate form:

$$\theta_1(p_d + x) - \theta_2 r + (1 - \theta_1 + \theta_2)c = p_f + m \tag{1.17}$$

where $\theta_1 = (P_d X)/(P_f M E)$; $\theta_2 = R/(P_f M E)$; $(1 - \theta_1 + \theta_2) = C/(P_f M E)$. In this formulation R and C are linked proportionally to nominal domestic income and θ_2 captures the share of net interest payments relative to imports. Substitution of Equations (1.10a) and (1.10b) into Equation (1.17) under the restriction that $c = y$, derives the balance of payments constrained growth rate that accounts for net interest payments and sustainable external debt.

$$y_{BP} = \frac{\theta_1 \beta z - \theta_2 r + (1 + \theta_1 \alpha + \gamma)(p_d - p_f - e)}{\varepsilon - (1 - \theta_1 + \theta_2)} \tag{1.18a}$$

If terms of trade are constant in the long-run, Equation (1.18a) yields:

$$y_{BP} = \frac{\theta_1 \beta z - \theta_2 r}{\varepsilon - (1 - \theta_1 + \theta_2)} \tag{1.18b}$$

Assuming a zero current account deficit $(1 - \theta_1 + \theta_2 = 0)$ yields:

$$y_{BP} = \frac{\theta_1 \beta z - (1 - \theta_1) r}{\varepsilon} \tag{1.18c}$$

and if the rate of net interest payments is zero $(r = 0)$ or insignificant $(\theta_1 = 1)$, Equation (1.18c) reduces to Thirlwall's Law:

$$y_{BP} = \frac{\beta z}{\varepsilon} \tag{1.18d}$$

An often omitted form of capital inflows is net transfers (I)—remittance inflow. The unique feature of net transfers is that they have no corresponding debt obligations, since these are gift transfers from friends and families living in more developed countries (Alleyne et al. 2008). Alleyne and Francis (2008) is the first to incorporate net transfers into a balance of payments constrained growth model. They amend the balance of payments identity as follows:

$$P_d X + C - R + I = P_f M E \tag{1.19}$$

and in rates of change:

$$\theta_1(p_d + x) - \theta_2 r + \theta_3 i + (1 - \theta_1 - \theta_3 + \theta_2)c = p_f + m \tag{1.20}$$

where $\theta_1 = (P_d X)/(P_f M E)$; $\theta_2 = R/(P_f M E)$; $\theta_3 = I/(P_f M E)$; $(1 - \theta_1 - \theta_3 + \theta_2) = C/(P_f M E)$. Substitution of Equations (1.10a) and (1.10b) into Equation (1.20) under the restriction that $c = y$, derives Alleyne and Francis (2008)'s balance of payments constrained growth rate that accounts for net interest payments, net transfers and sustainable external debt.

$$y_{BP} = \frac{\theta_1 \beta z - \theta_2 r + \theta_3 i + (1 + \theta_1 \alpha + \gamma)(p_d - p_f - e)}{\varepsilon - (1 - \theta_1 - \theta_3 + \theta_2)} \tag{1.21a}$$

If terms of trade are constant in the long-run, Equation (1.21a) yields the following, where it is transparent that the growth rate of net interest payment and net transfers decreases and increases the balance of payments constrained growth rate respectively.

$$y_{BP} = \frac{\theta_1 \beta z - \theta_2 r + \theta_3 i}{\varepsilon - (1 - \theta_1 - \theta_3 + \theta_2)} \tag{1.21b}$$

Alleyne and Francis endogenize net transfers as shown below, where $\psi < 0$ is the income elasticity of net transfers. Equation (1.22a) says that net transfers are positively and negatively related to foreign and domestic income respectively. The basic mechanisms are as follows: 1. As friends and relatives earn more income in the rest of the world, they remit more transfers to the domestic economy, 2. As domestic income contracts, friends and families remit more transfers and 3. As domestic income increases, residents in the domestic economy remit transfers to the rest of the world to support the education of children abroad and other relatives and friends in need (Alleyne and Francis 2008).

$$I = \left(\frac{Y P_d}{Z P_f E}\right)^{\psi} \tag{1.22a}$$

In growth rate form:

$$i = \psi(y + p_d - z - p_f - e) \tag{1.22b}$$

Substitution of Equation (1.22b) into Equation (1.21b) under the assumption of constant terms of trade yields:

$$y_{BP} = \frac{\theta_1 \beta z - \theta_2 r + \theta_3 \psi(-z)}{\varepsilon - (1 - \theta_1 - \theta_3 \psi + \theta_2)} \tag{1.23}$$

Equation (1.23) is a fully specified long-run balance of payments constrained growth model that incorporates capital inflows. It takes into account external debt sustainability, net interest payments and net transfers and their direct and countervailing effects on the balance of payments constrained growth rate. Moreover, Equation (1.23) shows that growth in external demand (z) increases the balance of payments constraint growth rate through two channels: 1. Growth in export demand ($\theta_1 \beta z$) and 2. Growth in net transfers $\left(|\theta_3 \psi(-z)| > 0\right)$. However, Alleyne and Francis (2008) add the important qualification that the various effects of capital inflows must be interpreted with caution, since the share parameters (θ) are not constant.

1.3.4 Technological Gaps and Non-Linear Spillovers

Dixon and Thirlwall (1975) formally demonstrate that differences in the Kaldor-Verdoorn coefficient engender uneven growth between countries. The key limitation of cumulative growth models is that they pay scant attention to technological spillovers from frontier countries and learning constraints within laggard economies. These have been the principal concerns of the technological gap approach to economic growth (Fagerberg 1987; 1988; Verspagen 1991). This approach is summarized by (Fagerberg 1987: pp.88) in four propositions:

- There is a close relation between a country's economic and technological development
- Economic growth is a positive function of the rate of growth in the technological level of the country

- It is possible for a country facing a technological gap to increase its rate of economic growth through imitation or catching-up
- The rate at which a country exploits the possibilities offered by the technological gap depends on its ability to mobilize resources for transforming social, institutional and economic structures.

The technological gap literature posits that a country's rate of growth depends on its level of technological capabilities and that technological backwardness can be beneficial to the laggard economy through the process of technological catch-up (Veblen 1915; Gerschenkron 1962; Maddison 1982; Abramovitz 1986; Maddison 1994; Helpman 2004).

Technological diffusion takes effect through knowledge spillovers from frontier countries and since these effects are greater through trade interaction, Baumol et al. (1994) contend that more extensive trade increases the rate of technological diffusion and ergo, accelerates the rate of technological convergence. This implies that spillover effects must be maximized in EMUs and other regional groupings where intra-regional trade is extensive—predicting technological convergence from deeper economic integration. However, the technological gap approach demonstrates that a country's domestic capacity to absorb knowledge spillovers is a fundamental determinant of technological convergence. Scholars like Fagerberg (1987; 1994), Verspagen (1991; 1993) and Fagerberg and Verspagen (2002) argue that the use of modern technology and its adaptation to local context can be cost prohibitive in laggard economies and that limited absorptive capabilities can undermine the catching-up process. Several studies have shown that the size of the initial technological gap determines a country's learning/absorptive capabilities (Abramovitz 1986; 1995; Nelson and Phelps 1966; Rogers 2004). In a series of papers, Abramovitz makes the case that a country's social capabilities—its social attitudes to learning, educational attainment, organizational and commercial skills etc.,—and technological congruence[6]—the appropriateness of the leader's technology to the follower's economy—determine a country's potential to catch-up (Abramovitz 1986; 1995). In two seminal pieces, Verspagen formalized the non-linear relationship between the technological gap and a country's ability to absorb knowledge spillovers (Verspagen 1991; 1993). The central idea is that as the initial size of the technological gap exceeds a threshold, the process of

[6]In the early 1950s Caribbean, there was an intense debate between A. Lewis and Plantation School scholars on the appropriateness of imported technology. Lewis made the case that foreign investment will accelerate the pace of technological diffusion and thereby, economic growth. For a full treatment of this debate, see Figueroa (1996) .

catching-up is undermined as the country lacks the learning capabilities to utilize the knowledge spillovers.

Let the technological gap (G) be defined as:

$$G = \frac{S_f}{S_h} \tag{1.24a}$$

where S_f and S_h are the existing stock of knowledge or technological capabilities in the foreign and the home (laggard) country respectively. Verspagen (1991) presents the following non-linear function of technological catch-up:

$$s_h = aGe^{-G/\varphi} \tag{1.24b}$$

where s_h is the rate of technological progress in the laggard economy; $0 < a \leq 1$ is the potential rate of catch-up (which is proportional to the size of G); $\varphi > 0$ is the economy's intrinsic learning capacity and $e^{-G/\varphi}$ captures absorptive capacity. The latter shows that absorptive capacity is negatively related to the size of the technological gap but increases with learning capacity.

Verspagen's formulation presents two regimes:

- Technological catch-up ($G < \varphi$), i.e. high learning capacity and small G
- Falling behind ($G > \varphi$), low learning capacity and large G.

As noted by (Rogers 2003: pp. 50), a quadratic formulation of Verspagen's model may be more intuitive and straightforward in terms of empirical estimations:

$$s_h = \rho(G - cG^2) \tag{1.24c}$$

where $\rho > 0$ is a response parameter and $c > 0$ is a constant that reflects the appropriateness of the imported technology and other features of absorptive capacity. As illustrated in Equation (1.24c), when the technological gap (G) is small, there are opportunities for technological emulation and knowledge spillovers that accelerate the pace of technological progress in the laggard country. However, as the technological gap increases beyond a critical point ($\rho - 2\rho G$), technological spillovers are reduced due to the lack of indigenous capabilities required to learn from the frontier.

1.3.5 Conditional Convergence and the BPCG Model

Several studies within the balance of payments constrained growth literature have outlined the various conditions for technological convergence. Two basic propositions emerge:

- Technological convergence is possible when an economy has a high share of manufacturing output in gross domestic product and an undervalued foreign exchange rate
- The probability of technological catch-up increases with improvements in an economy's National System of Innovation (NSI).

These insights are derived from North-South models,[7] where Kaldor-Verdoorn effects do not produce explosive dynamics in the South because of the balance of payments constraint (Cimoli et al. 2019; Porcile and Spinola 2018; Missio and Gabriel 2016; Gabriel et al. 2016; Ribeiro et al. 2016; Cimoli and Porcile 2014; Da Silva Catela and Porcile 2012; Caldentey and Ali 2011; Cimoli and Porcile 2010; Cimoli et al. 2010; Botta 2009; Porcile et al. 2007; Meliciani 2002). These studies find that a currency devaluation increases firms' profit share, capital accumulation and technical change, when the share of manufacturing output is already high. For example, Gabriel et al. (2016) show that currency devaluation increases the Kaldor-Verdoorn effect and learning capabilities, therefore, promoting technological convergence. A key ingredient in these models is the role of the National System of Innovation—the set of formal and informal institutions that coordinate the interactions of firms, research institutes and universities involved in the process of learning and technical change (Freeman 1995). It follows that public and private investment in schooling, R&D, ICT infrastructure, efficiency wages and effective coordination among various institutions etc., enhance absorptive capabilities and increase the probability of technological catch-up. Hence, these scholars advocate for extensive use of industrial and technology policy to accelerate the pace of technological convergence. These findings are similar to the conclusions drawn from the technological gap approach and cumulative causation growth models. However, the crucial difference is that these North-South models impose a balance of payments constraint.

[7]See Findlay (1980), Taylor (1981b), Burgstellar and Saavedra-Rivano (1984), Dutt (1989) and Darity (1990) for early formulations of North-South models, where the principal conclusions are that technological change engenders asymmetries in output and employment growth between countries and that free trade and capital mobility can undermine the catching-up process.

1.3.5.1 National System of Innovation

NSI refers to the framework within which government forms and implements policies to influence the innovation process (Metcalfe 1995). Government assumes a leading role in coordinating the various actors (universities, firms, private & national research councils, private & national financial institutions etc;) to accelerate the process of technological emulation, innovation and diffusion (Cimoli 2014; Cimoli and della Giusta 2000; Freeman 1995; Nelson and Rosenberg 1993). The importance of public sector investment and the coordinating role of government were recognized by classical development thinkers, who explained that economic development and diversification require a simultaneous big-push across several sectors (Rosenstein-Rodan 1957; Nurkse 1963). Cimoli (2014) explains that the NSI sets the constraints and opportunities each innovator or firm faces, e.g. the availability of skilled labour, cheap capital and information on new technologies etc. This body of scholarship concludes that the role of government is to create and diffuse general purpose technologies, develop the technological infrastructure in both private and public sectors and expand certain industries that advance technical change (Freeman and Soete 1997). In the case of emulation and reverse engineering, Freeman (1995) states the following.

> [...] nations should not only acquire the achievements of more advanced nations, they should increase them by their own efforts.

The National System of Innovation is essential to the process of emulation since this depends on technical institutes and re-training schemes, the national acquisition of new technologies and diffusion by means of technology shows or parks. It follows that the NSI and government policy are important for both technological leader and laggard but in the interest of technological convergence, these are even more important for laggard economies.

In her celebrated book, Mazzucato (2013) has recently documented the role the U.S. government played in the commercial success of Apple technologies, modern smartphones and Google's search engine. She shows that the U.S. government funded both national and private research councils to undertake high-risk but innovative research projects, e.g. space exploration, nuclear technologies, GPS navigation etc. Her work builds on the scholarship of innovation systems, which emphasizes that a country's national capabilities are greater than the sum of its individual firm-level capabilities (Lall 2000; Freeman 1995). This literature underlines the point that governments do not merely fix market failures but also actively create and shape markets (Mazzucato 2013; Freeman 1995; Polanyi 1994). In recent work, Mazzucato and

Semieniuk (2017) and Perez (2013) make the case that government procurement policy serve the twin purposes of providing early stage high-risk finance and accelerating the diffusion of new technologies. But national procurement policy is an old strategy of technological and industrial upgrading. A series of historical studies carefully document how governments in East Asia, Old Europe and the U.S. led the charge on technological innovation, acquisition and theft (Evans 2012; Reinert 2008; Chang 2002; Freeman 1995; Polanyi 1994). For example, Freeman (1995) provide a historical survey that show how Prussia—later Imperial Germany—overtook Industrial Britain by establishing training institutes that modified and improved British machines. Prussia also actively pursued British engineers when tacit knowledge was important. Further, Freeman along with Chang (2002) demonstrate how the U.S was even more successful than Imperial Germany in overtaking Britain during the second half of the nineteenth Century. These scholars contend that intellectual theft was rampant between the U.S. and Britain and that governments in both countries were the leading actors in this regard. The central idea here is that based on both historical and recent evidence, governments cannot be divorced from innovation and technological progress.

Mazzucato and Penna (2015) make the case that public investment is particularly complementary to private ingenuity in developing countries. They show that the Brazilian Development Bank provide low-cost finance to key infrastructure projects and basic industries through a combination of direct lending to industry and indirect financing via private financial institutions. In a series of papers, Keith Nurse argues that inadequate funding for R&D and data infrastructure are the key reasons for little innovation[8] in the creative industry in the Caribbean (Nurse 2000; 2001; 2011). According to Nurse and Hendrickson et al. (2012), Caribbean countries have failed to establish the data infrastructure to capture the economic contribution of their creative industry, thereby, undermining firms' ability to claim royalties and the incentive to develop new products within the sector. Martins Neto and Porcile (2017) is one study that directly connects public investment to non-price competitiveness in a BPCG model, where firm-level innovation and emulation in laggard economies are based on efficient public utilities and a skilled workforce. In this regard, Perrotti and Sanchez (2011) and Calderon and Serven (2003) provide evidence to show that feeble public investment in infrastructure is a contributory factor to the widening of the productivity gap between Latin

[8] See Alleyne et al. (2017) and Nurse (2007) for evidence that Caribbean countries record substantially lower coefficients of innovation as compared to their peers in Latin America.

American and Asian countries.[9]

1.3.6 Endogenizing the Trade Elasticities

Since Thirlwall (1979) several studies have extended the BPCG model to account for non-price competitiveness. Fagerberg (1988) was the first to explicitly model the technological gap in the BPCG model and Meliciani (2002) provides an extension to account for differences in technological specialization across countries. In Fagerberg's formulation, non-price competitiveness is determined by the twin factors of the technological gap and a country's capacity to deliver goods and services to its export markets. In the latter case, Fagerberg refers to an economy's physical capital stock and its production capacity to meet export demand. These determinants are included as arguments in a country's export and import demand functions and prove to be statistically significant for 15 OECD countries between 1961-1983. In Meliciani's extension, countries that specialize in fast-growing technologies are better positioned to absorb technological spillovers and thus, benefit from faster balance of payments constrained growth rates.

Since these early works, the emerging consensus is that technological convergence between laggard and frontier economy drives the foreign trade elasticities (Davila-Fernandez et al. 2018; Porcile and Spinola 2018; Ribeiro et al. 2016; Cimoli and Porcile 2014; Feijo and Lamonica 2013; Da Silva Catela and Porcile 2012; Krugman 1989).[10] For example, in an aggregate BPCG model, Ribeiro et al. (2016) modeled the technological laggard as a one-sector economy that imports intermediate capital goods and endogenized its foreign trade elasticities as a positive function of the inverted technological gap. As the laggard economy converges to the technological frontier, it is better able to produce higher quality goods, which are associated with higher income elasticities in export markets.[11] This study shows that firm-level investment in R&D promotes technological convergence and thereby, increases the equilibrium growth rate. In other formulations, particularly North-South models, the income elasticity of exports is modeled as a positive function of economic complexity, in turn determined by the techno-

[9] In the case of an EMU, see Makkonen (2013) for evidence that the Eurozone periphery—Portugal, Spain, Italy and Greece—reduced public investment in R&D since 2008.

[10] Numerous studies have empirically verified that technological change increases non-price competitiveness as measured by the trade elasticities (Gouvea and Lima 2010; Romero and McCombie 2016b; 2018; Cimoli et al. 2010; Martins Neto and Porcile 2017).

[11] Fiorillo (2001), McCombie and Thirlwall (1994) and Fagerberg (1988) argue that technological progress improves product quality, while Krugman (1989) makes the case for product differentiation.

logical gap (Cimoli and Porcile 2014). The latter scholars argue that specialization patterns are determined by relative technological capabilities and that income elasticities of export vary by technological specialization. They argue that medium- to high-technology commodities are associated with higher income elasticities as compared to say, low-technology goods in the agricultural sector. This approach to endogenizing non-price competitiveness is similar to the work of Da Silva Catela and Porcile (2012). This study finds that faster balance of payments constrained growth rates are associated with higher shares of high-technology exports in the total volume of exports.

Other specifications build on the scholarship that emphasize how technical change is embodied in machines or a country's capital stock (Kaldor and Mirrless 1962). Feijo and Lamonica (2013) build on this idea and modeled the ratio of foreign trade elasticities as a function of the average age of capital goods between countries. These scholars contend that the more modern an economy's capital goods, the greater the technological content of its output and the faster is its balance of payments constrained growth rate. In this formulation, the ratio of trade of elasticities—non-price competitiveness—is dependent on the relative effort to accumulate new capital goods. However, this study finds that a large pool of informal labour in laggard economies can reduce the rate of capital accumulation and by extension, perpetuate the technological gap.

One innovative contribution to the determinants of non-price competitiveness is the seminal work of Araujo and Lima (2007). These scholars are the first to derive Thirlwall's Law using a multi-sectoral BPCG model, inspired by the work of Pasinetti (1981; 1993) on structural economic dynamics.[12] In a two-country model, where average productivity is higher in the foreign country, trade emerges when certain sectors in the laggard economy have higher levels of productivity as compared to the technological leader. Therefore, trade and production specialization are determined by the differences in sectoral productivities. They demonstrate that the aggregate ratio of foreign trade elasticities is simply the weighted average of sectoral elasticities, so that changes in the sectoral composition of the economy can alter the weighted trade elasticities. For example, a sectoral reallocation biased towards technology-intensive sectors can increase the aggregate foreign trade elasticities. Alternatively, for given sectoral elasticities, an economy's BPCG rate increases if its structure of demand changes and increases a sector's share in total exports. The central contribution here is to demon-

[12] See Romero and McCombie (2016b), Gouvea and Lima (2013), Gouvea and Lima (2010) and Bagnai (2010) for empirical support of the multi-sectoral Thirlwall's Law.

strate how changes in sectoral composition can affect the equilibrium growth rate through changes in the weighted average of foreign trade elasticities. In much earlier work, Setterfield (1997), Pasinetti (1981) and Cornwall (1977) underline the importance of sectoral changes for non-price competitiveness. They contend that as household income grows, consumers move through a commodity hierarchy, where different quality goods have different income elasticities of demand. It follows that an economy's production structure must continually evolve with changes in the structure of demand to maintain a high ratio of foreign trade elasticities. Richardson (1965) explains why the latter may be unlikely. He notes that a country may become locked-in to a certain stage of the commodity hierarchy, if the interrelatedness between its existing industries and capital stock prevent the emergence of new industries. This lock-in effect is an important mechanism by which an economy's trade elasticities can be depressed as the structure of demand changes. Thirlwall (1997) makes a similar suggestion and proposes an inverted-U relationship between an economy's income elasticity of exports and its production transformation from agriculture to manufacturing. He credits the inverted relationship to lock-in effects in outdated industrial structures. McCombie and Roberts (2002) employ a similar set-up of non-linearity between the trade elasticities and economic growth. In this study, poor previous growth rates create pressures to reform the production structure, thereby, increasing the trade elasticities. McCombie and Roberts explain that the pressure for reform comes from the citizenry—concerned about employment—and the private sector—concerned about low returns on investment. In their formulation, the non-linearity emerges as rapid growth rates produce lock-in effects and depress the trade elasticities.

In recent work, Davila-Fernandez et al. (2018) formalize Thirlwall (1997)'s suggestion of an inverted-U relationship between the trade elasticities and production transformation. The basic argument in this study is that non-price competitiveness is directly related to economic complexity and diversification.[13] The key mechanism is that at low levels of diversification, an economy's marginal propensity to import is relatively high, which produces a comparatively high income elasticity of import demand and undermines non-price competitiveness. But what explains the inverted-U relationship? These scholars build on the work of Abramovitz (1995) and formally demonstrate in an aggregate BPCG model that a continuous process of diversification is inevitably constrained by an economy's social capability—its capacity to continuously adapt to new institutions and technologies. This study presents an interesting twist

[13] See Hidalgo and Hausmann (2009), Hidalgo et al. (2007) and Hausmann et al. (2007) for evidence that economic complexity and diversification increase economic growth.

to the idea of lock-in effects. It shows that rapid diversification produces a payoff structure with uncertain distributional implications and consequently, creates incentives to resist change or further diversification.[14] In their basic set-up, they model a small open economy without a government sector and allow for Kaldor-Verdoorn effects. Output growth below the upper limit of social capabilities, increases productivity growth and non-price competitiveness through production diversification. However, as growth and diversification create distributional uncertainties, sectoral concentration ensues and depresses the trade elasticities.

In other approaches, several studies build on Kaldor (1981) and endogenize the trade elasticities as a function of output growth—the Kaldor-Verdoorn effect (Porcile and Spinola 2018; Setterfield 2011; Fiorillo 2001). An interesting formulation of this approach is the work of Fiorillo (2001). This study presents a multi-sectoral Kaldorian export-led growth model, where the Kaldor-Verdoorn effects are localized by sector. Fiorillo proposes a profits-technology-income elasticity of exports causal chain. As output growth increases sectoral productivities, cost competitiveness is enhanced through lower unit labour costs, which increase firm-level profits. These in turn fund firm-level innovation and R&D, which provide for improvement in product quality and differentiation. Thus, this study shows that Kaldor-Verdoorn effects at the sectoral level can increase the weighted trade elasticities and activate further rounds of output growth. However, Fiorillo indicates that the process of cumulative causation is limited by countervailing forces. Namely, retaliatory currency devaluations from trading partners, higher wage demand as firm-level profits rise and increased rates of entry into the industry as profits grow.

Several other scholars incorporate the ideas of Kaldor (1981) and self-financing at the firm-level in BPCG models and endogenize the trade elasticities as a function of the real exchange rate. For instance, Missio et al. (2017) extends Araujo and Lima (2007)'s multi-sectoral BPCG model and allow for Kaldor-Verdoorn effects. In this model, a currency devaluation reduces real wages and increases firm-level profits, which provides the necessary self-financing required for innovation and R&D at the sectoral level. Moreover, the study shows that the share of technology-intensive and higher value-added sectors is an important determinant of productivity spillovers and economic growth. It follows that a short-term policy of currency devaluation, which promotes technological change and increases the share of high-technology sectors, can accelerate an economy's long-run growth rate. In earlier work, Missio and Jayme

[14] For evidence that rapid growth produces strong diversification effects and then strong concentration effects, see Romano and Trau (2017), Haraguchi and Rezonja (2013) and Imbs and Wacziarg (2003).

(2012) incorporate the continuum of goods approach into a multi-sectoral BPCG model. In this set-up, they account for two types of commodities: Ricardian commodities produced by the laggard economy and innovative commodities produced by the frontier country. In their model, labour is the only production cost, so that relative labour costs determine specialization in trade. Under this assumption, a currency devaluation reduces real wages (relative labour cost) and allows the laggard economy to produce innovative commodities. Given this sectoral change, the economy's need for imported capital goods falls and this reduces the income elasticity of imports. Further, unlike Missio et al. (2017), a currency devaluation also increases capital accumulation and the income elasticity of exports as demonstrated by Feijo and Lamonica (2013). Missio and Jayme (2012) conclude that exchange rate policy can have profound long-run growth effects.

Ribeiro et al. (2016) add an important note of caution to the thesis that devaluations reduce wage shares and engender technological progress. Unlike the previous studies, Ribeiro and his co-authors present a non-linear relationship between technological change and real wages (wage share) in an aggregate BPCG model. This modeling approach builds on the work of Lima (2004), who demonstrates that too low or high wage shares reduce the rate of technological change. The key implication is that devaluations only increase technological progress and the trade elasticities if the wage share (real wages) is initially high. These scholars formally demonstrate that devaluations in a low wage share economy, retards technological progress and long-run economic growth.

As demonstrated thus far, the literature is partial to the income elasticity of exports and only a handful of studies bring the income elasticity of imports into central focus. A recent contribution in this line of research is the work of Ribeiro et al. (2016). Their complete specification of the foreign trade elasticities include the inverted technological gap and the wage share. Since the mechanisms of the former have been fully discussed above, the author focuses exclusively on the role of the wage share here. In this model, the wage share has ambiguous effects on the trade elasticities. Higher wage shares can induce a capital substitution and allow for the production of capital-intensive goods (higher income elasticity of exports), while lower wage shares can reduce the income elasticity of exports by incentivizing capitalists to produce labour-intensive commodities. In the case of income elasticity of imports, a higher wage share increases and decreases the demand for luxury imports for workers and capitalists respectively. The net effect determines how changes in income distribution affect the overall demand for luxury imports and by extension, the income elasticity of imports.[15] Notwithstanding the ambiguous effects of changes in the wage share on the trade elasticities, Ribeiro et al. (2016) assume that a rising wage share has positive effects on non-price competitiveness. These scholars place greater premium on the capital substitution effects of an increase in the wage share.

In much earlier work, Thirlwall and Hughes (1979) and Thirlwall and White (1974) demonstrate that the tightness of the labour market can increase the demand for imports independent of the level of income. It follows that the income elasticity of import demand increases when the labour constraint is binding. More recently, Palley (2003) endogenizes the income elasticity of import as an inverse function of excess capacity, so that capacity constraints reduce the ratio of foreign trade elasticities. Other strands of the literature make the case that lower income inequality (higher wage share) reduces the demand for luxury imports and by extension, increases the ratio of foreign trade elasticities (Francois and Kaplan 1996). This result hinges on the assumptions that domestic and imported consumer goods are substitutes and that the working class does not emulate the consumption pattern of the rich. Absent these conditions, lower income inequality can reduce the foreign trade elasticities and non-price competitiveness. Porcile et al. (2007) add an interesting twist to the literature on distribution and the trade elasticities. Porcile and his co-authors employ the efficiency wage theorem[16] in an aggregate BPCG model and demonstrate how wage increases can improve workers' capacity to learn and imitate foreign technologies, so that a rise in the wage share can lead to specialization in goods with higher income elasticity of exports. This result holds up to a threshold level of real wages (wage share), after which higher wage shares undermine non-price competitiveness.

1.4 Conclusion

This survey has summarized the main themes in the balance of payments (BP) constrained growth literature. Namely, its historical origins, the elasticity pessimism and relative price adjustments, capital flows and endogenous trade elasticities. The review is partial to aggregate

[15]It is not inevitable that rising demand for luxury imports increases the income elasticity of imports. This requires that the foreign country alters the quality of its product or the structure of its production to meet the new structure of demand.

[16]Higher wage shares provide for better access to education and health care (Ranis and Stewart 2002) and stronger motivations to work (Shapiro and Stiglitz 1989).

BP models but where it is instructive, multi-sectoral BP models are discussed. One limitation of this review is that it omits criticisms raised against the balance of payments constrained growth model and the corresponding replies, but the interested reader is encouraged to consult McCombie (2011) for extensive details.

The structured survey is able to identify several gaps within the class of BP models. First, the monetary economy is largely omitted with the exception of the nominal exchange rate. The role of finance and banking and how these interact with the BP constraint is an obvious gap within the literature. Second, distributional analyses are only undertaken within two-class models but there are strong reasons why a three-class approach might be more insightful. For example, financial and land rentiers can undermine many of the predicted results in two-class models and thereby, derive new analytical insights and policy scenarios. This approach is particularly important given the prominence of open capital accounts, the power of global financial markets and oligopolistic banks in poor and developing economies. Third, when one accounts for the potential Dutch Disease effects in currency unions, capital inflows can produce new countervailing effects unrelated to interest payments and currency crises. To take one example, capital flows can reduce medium-run economic growth when it produces Dutch Disease effects and lower productivity growth. This is particularly problematic in currency unions as it promotes divergence is relative unit labour costs. This leads to the final point. Given renewed interest in regional integration, BP models should further investigate growth dynamics under assumptions of fixed exchange rate regimes and fiscal policy bounded by limits imposed through regional agreements. Should countries opt for deeper regional integration in light of rising protectionism, BP models should assume a stronger regional focus.

Chapter 2

Production Structure, Capital Flows and The Short-Run–Medium-Run Macrodynamics

2.1 Introduction

Economic integration can take many forms, some more conducive to development and convergence than others. Colonialism is perhaps the best example of asymmetrical integration, where the core economy—the technological leader—maintains its economic and technological advantages by decree. In other words, the colony—the technological laggard—is prevented from embarking on the process of economic development and technological catch-up. Numerous scholars argue that the present form of globalization, European integration and regional groupings reproduce this asymmetrical relation of core-periphery (Stockhammer et al. 2015; Reinert and Kattel 2014; Simonazzi et al. 2013; Girvan 2009; Blecker 1996). Proponents of this view posit that the economic policy framework at the level of the world economy or the Eurozone, in the case of a regional grouping, does not provide adequate space for technological catch-up through industrial policy and various forms of demand management. But neoclassical theory of convergence contends that closer economic ties at the world level through trade liberalization etc., or deeper economic integration within regional groups, will close the gap between rich and poor countries (Baumol et al. 1994). These scholars argue that the period of convergence engenders temporary external imbalances and capital flows toward laggard economies that facilitate the catching-up process (Blanchard and Giavazzi 2002).

This chapter makes several key contributions to the literature on capital flows, convergence and economic growth. It presents a balance of payments constrained growth model within a regional setting, an Economic and Monetary Union (EMU). The first contribution the chapter makes is to the balance of payments constrained growth literature. It formalizes a new channel through which capital flows can have ambiguous effects on the balance of payments constrained growth (BPCG) rate. The model shows that when a technological gap exits between two countries that share a common currency, capital flows toward the technological laggard can deteriorate its production structure and produce lower productivity growth. In other words, capital flows can engender a divergence in relative unit labour cost. As the laggard economy loses cost competitiveness, it simultaneously produces a lower balance of payments constrained growth rate. Other works within the balance of payments constrained growth framework do emphasize the growth-reducing effects of capital inflows but these works focus on the debt and foreign currency crises channels (Filho et al. 2013; Vera 2006; Curado and Porcile 2002). For example, Filho et al. (2013) and Curado and Porcile (2002) argue that faster capital inflows expose an economy to sudden stops and lead to debt accumulation and high interest payments, which constrain economic growth. These studies along with Alleyne and Francis (2008), Moreno-Brid (2003) and Barbosa-Filho (2001) illustrate how capital inflows can reduce the BPCG rate through debt repayment. It follows that the channel advanced in this chapter is closer to the Dutch Disease mechanism, where capital inflows lead to deindustrialization and lower productivity growth. Unlike this traditional literature (Botta 2017; Rajan and Subramanian 2011; Paldam 1997), the Dutch Disease effects in this chapter are captured within the context of an EMU and a balance of payments constrained growth model.

One important implication of this finding is that cost and non-cost competitiveness cannot be neatly divided—non-cost factors like production structures or economic complexity can affect cost competitiveness. This insight leads to the second contribution of this chapter, by providing some clarity on the intense debate regarding the role of unit labour costs in driving intra-Eurozone current account imbalances (Storm and Naastepad 2016; 2015a; Stockhammer et al. 2015). Germany's price competitiveness may be more related to its super technological capabilities rather than wage suppression per se. Alternatively, it can be said that the Eurozone periphery has lost price competitiveness partly because of a deterioration in their production structures. This interpretation produces the policy conclusion that technology policies rather than labour market reforms are needed in the Eurozone periphery.

The third contribution relates to how capital flows lower the BPCG rate and provide for weaker effects of induced technological change, which widens the technological gap between core and periphery. Moreover, the model shows that when the demand regime is wage-led, capital inflows increase the short-run growth rate and widen the external deficit until equilibrium is restored by way of a financial crisis. There are strong evidence in the case of the

Eurozone to support these results. Several empirical studies show that the Eurozone periphery has lost value added share in medium- and high-technology exports since the introduction of the Euro (Storm and Naastepad 2015b; Botta 2014; Simonazzi et al. 2013; Reinstaller et al. 2012). Rapid capital flows toward the Eurozone periphery led to significant growth in aggregate demand and unit labour cost, a deterioration in their production structures and a rise in external imbalances that eventually ended in a sudden stop of capital inflows (Storm and Naastepad 2015b). To the best of the author's knowledge, this is the first time that the dynamics of intra-Eurozone divergence are formalized.

These results are driven by a crucial assumption—that the technological gap between the laggard and frontier economy exceeds the threshold that maximizes technological spillovers. It follows that the size of the initial technological gap matters for regional cohesion and the growth and technology effects of capital flows. The key implication here is that members or potential members of an EMU must pass the litmus test of the maximum distance from the frontier country, lest divergence threatens regional solidarity. However, this is a highly restrictive condition for membership in regional groupings. As such, the model presents results that demonstrate how technology policy in laggard economies can promote technological convergence and sustain community cohesion. This is finding supports recent calls for Regional Innovation Systems and fiscal unions at the level of regional groupings that fund public investment and industrial policies in peripheral countries (Reinert and Kattel 2019; Stockhammer et al. 2019; 2015; Botta 2014). The principal insight here is that regional cohesion and convergence are possible even when the initial technological gap is large, if the community establishes a Regional Innovation System to reduce technological asymmetries.

The final key contribution relates to the importance of demand regimes in influencing how laggard economies transition to a medium-run growth and technological path. For example, the above results no longer hold when the laggard economy has a profit-led demand regime. As opposed to the wage-led regime, capital inflows produce a short-run contraction but medium-run convergence or divergence depending on the net-effect of capital inflows on the balance of payments constrained growth rate. When the positive effects dominate, capital flows produce a short-run contraction but economic recovery in the medium-run. However, when the negative effects dominate, the laggard economy experiences a short-run contraction and a medium-run stagnation in both economic growth and technological capabilities. These varying results demonstrate the importance of demand-regimes for regional integration.

Several conclusions can be derived from the multitude of results presented in this chapter.

First, the size of the technological gap between countries in an EMU is consequential for convergence in technological capabilities. Second, demand-regimes matter for relative economic performance and ergo, regional cohesion. Third, capital flows within a community can produce both convergence and divergence effects. Fourth, given the prevailing conclusions, the design framework at the regional level is fundamental to compensate for the forces of divergence. Finally, if political consensus is lacking at the regional level as to the design framework for a fiscal union/Regional System of Innovation, then the principal convergence criteria must include demand-regimes and the size of the technological gap.

The remainder of the chapter is organized as follows. Section 2.2 presents the theoretical model and section 2.3 outlines the first equilibrium solution and comparative dynamic results. In section 2.4, the chapter formalizes the demand-regimes and in section 2.5, the second equilibrium solution is derived and new comparative dynamic results are discussed. Finally, the chapter concludes in section 2.6.

2.2 Model

Assume that an Economic and Monetary Union (EMU) consists of two countries: a technologically advanced foreign country and a technological laggard—the home country. An independent central bank issues the common currency and there is no fiscal union. Each country is obligated by treaty to maintain balanced fiscal accounts and observe both debt and deficit limits. It follows that there is little room for counter-cyclical fiscal policy. Thus, in this model, the role of government is ignored and it is assumed that all fiscal obligations are met. Given the EMU, both countries are financially integrated and capital can flow freely between countries. Due to the latter and the elimination of exchange rate risks, interest rates are assumed to converge between countries. Also, the home country is composed of two classes: a capitalist class with a given savings rate and a working class that does not save.

2.2.1 Production Structure

The home country produces a good of given technological complexity—knowledge input or know-how—by combining capital and labour in fixed coefficients, where output, employment and capital stock are Y, L and K respectively. The corresponding productivity coefficients are a and b and the fixed coefficient combination is determined by the existing stock of knowledge. The latter determines the difference in input efficiencies independent of relative factor prices.

$$Y = \min(aL, bK) \tag{2.1a}$$

For a given technological gap, home country produces a range of goods for which it has relative cost advantage. Consistent with the modeling approaches of Cimoli and Porcile (2010), Cimoli (1988) and Dosi et al. (1990), the home country loses cost advantage as the technological intensity of a commodity increases. It follows that for a given technological gap, relative cost differences are higher for technology-intensive goods. Assume that the continuum[1] of commodities with varying technological complexity can be ranked from the lowest complexity ($N = 0$) to the highest ($N = 1$).[2] For a given technological gap, the home country produces up to N^* when the following holds:

$$\frac{W_h}{a_h} \leq \frac{W_f}{a_f} = N^* \tag{2.1b}$$

where the wage rate and labour productivity are W and a respectively. Equation (2.1b) says that the home country specializes in a range of goods up to N^*, where it has a lower relative unit labour cost (W_h/a_h).[3] Moreover, for its given pattern of specialization up to N^*, only technological change can pierce the barrier of N^*, though losses in economic complexity can easily be experienced in the medium-run. The technological leader produces all goods beyond N^* but it also produces low-technology commodities too, demonstrating its absolute and comparative advantage over its peer. In this model, technological asymmetries is the defining factor for comparative and absolute advantages between the home and the foreign country. It can now be assumed that the home country specializes in the production of commodities with relatively low levels of technological intensity, see Figure 2.1.

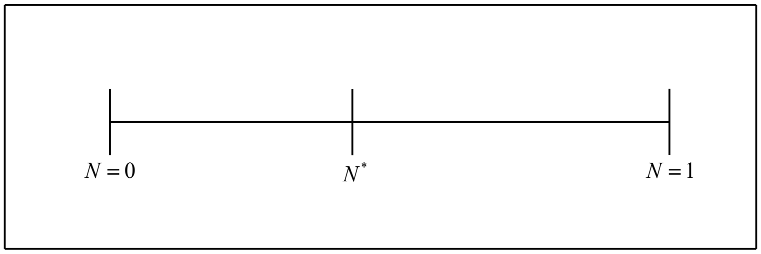
The continuum of goods is used only as an analytical device to organize thinking regarding patterns of specialization and its dynamics. It is assumed that the home country's production possibilities can move along the continuum of complex goods indicating changes in the production structure, either at the sectoral or at the commodity level. Just to fix ideas, consider

[1] See Dornbusch et al. (1977), Wilson (1980), Collins (1985) and Cimoli (1988) for earlier modeling approaches that employed a continuum of goods to define patterns of trade and specialization.

[2] For evidence that commodities can be ranked based on their complexity, see Hidalgo et al. (2007), Reinert (2008) and Hidalgo and Hausmann (2009).

[3] In this chapter unit labour cost (UCL) always refers to aggregate rather than sectoral ULC.

Figure 2.1: Technological Intensity and Specialization



an example at the aggregate level. *Ceteris paribus*, the home country moves leftward along the continuum of complex goods, if its auto-industry manufacturing firms decide to relocate in the foreign country. In this case, the home country's share of manufacturing in its gross domestic product declines, indicating a loss in medium- to high-technology commodities.

Given the prevailing specifications, this chapter defines production structure as the matrix of goods that a country produces for domestic and external demand. This matrix of production illustrates given technological capabilities and defines both opportunities and limits for learning and innovation, which influence demand and productivity growth in the medium- to long-run (Cimoli et al. 2016).

2.2.2 Evolution of the Technological Gap

Let the technological gap (G) be defined as:

$$G = \frac{S_f}{S_h} \tag{2.2}$$

where S_f and S_h are the existing stock of knowledge or technological capabilities in the foreign and the home country respectively. In turn, the evolution of the technological gap is given as follows, where lower cases indicate rates of change.

$$g = s_f - s_h \tag{2.3}$$

Equation (2.3) illustrates that the rate of growth of the technological gap depends on the differential rates of technological change between countries. It follows that there is technological convergence or divergence when $s_f < s_h$ or $s_f > s_h$ holds respectively. Technological change in the leader country is modeled according to Kaldor-Verdoorn's Law.

$$s_f = \rho_f + \lambda_f z \tag{2.4}$$

Verdoorn (1949) is the first to formalize the idea that there is a causal link between output growth and productivity growth and after Kaldor (1966) discovers empirical support for this claim, he later restates this thesis as a Law. The literature now identifies the well documented statistical relationship[4] as Kaldor-Verdoorn's Law (McCombie et al. 2002). Autonomous growth in technology is given by ρ_f, which depends on the autonomous rate of disembodied technical progress, the autonomous rate of capital accumulation and the degree to which technical progress is embodied in capital accumulation (Caldentey and Ali 2011; Dixon and Thirlwall 1975). In turn, induced technical change is captured by the Kaldor-Verdoorn coefficient (λ_f), which is a function of learning by doing and the extent to which capital accumulation is induced by economic growth (Dixon and Thirlwall 1975). Given autonomous technical change, Equation (2.4) says that the foreign country advances the technological frontier when its rate of output growth (z) increases.

The home country's technological progress function assumes the following form:

$$s_h = \rho_h + \lambda_h y_{BP} \tag{2.5}$$

where ρ_h is autonomous growth in technology and y_{BP} is the home country's balance of payments constrained growth rate. The latter is used instead of the actual growth to focus exclusively on the technology effects of long-run growth. Following Targetti and Foti (1997) and Caldentey and Ali (2011), the home country's Kaldor-Verdoorn coefficient (λ_h) is modeled as a non-linear function of the technological gap:

$$\lambda_h = \sigma_1 G - \sigma_2 G^2 \tag{2.6}$$

where λ_h increases with G up to the critical point of $(\sigma_1 - 2\sigma_2 G)$, after which the Kaldor-Verdoorn coefficient declines.[5] At low levels of G up to the critical point, there are opportu-

[4] For empirical evidence of Kaldor-Verdoorn's Law see Romero and McCombie (2016a), Romero and Britto (2017), Millemaci and Ofria (2014), Angeriz et al. (2008), McCombie et al. (2002), Fingleton and McCombie (1998) and Leon-Ledesma (1999).

[5] Magacho and McCombie (2017a) estimate Kaldor-Verdoorn's Law for 70 countries, including those with high, middle and low per capita income levels. They controlled for a linear technological gap and levels of schooling and find that the Kaldor-Verdoorn coefficient is higher in low-and middle-income countries in almost all manufacturing industries as compared high-income countries. However, the theoretical formulation in Equation (2.6) demonstrates that these empirical estimates may be biased upwards as the empirical exercise omitted the

nities for technological emulation and knowledge spillovers that accelerate the pace of technological progress in the home country. However, beyond the critical point, technological spillovers are reduced due to the lack of indigenous capabilities required to learn from the frontier. Note that the restriction ($\lambda_h > 0$) holds, so that technological gaps beyond the critical point only reduce the Kaldor-Verdoorn coefficient and never produce a negative value.

This quadratic technological progress function follows (Rogers 2003: pp. 50)'s formulation of Verspagen (1991)'s non-linear function of technological catch-up. It is based on the technological gap approach to economic growth that emphasizes technological spillovers from frontier countries and learning constraints within laggard economies (Fagerberg 1987; 1988; Verspagen 1991). The technological gap literature posits that a country's rate of growth depends on its level of technological capabilities and that technological backwardness can be beneficial to the laggard economy through the process of technological catch-up (Veblen 1915; Gerschenkron 1962; Maddison 1982; Abramovitz 1986; Maddison 1994; Helpman 2004). However, several scholars demonstrate that a country's domestic capacity to absorb knowledge spillovers is a fundamental determinant of technological convergence (Fagerberg 1987; 1994; Verspagen 1991; 1993; Fagerberg and Verspagen 2002). These scholars argue that the use of modern technology and its adaptation to local context can be cost prohibitive in laggard economies and that limited absorptive capabilities can undermine the catching-up process. Other scholars contend that the size of the initial technological gap determines a country's learning or absorptive capabilities (Abramovitz 1986; 1995; Nelson and Phelps 1966; Rogers 2004). In a series of papers, Abramovitz makes the case that a country's social capabilities—its social attitudes to learning, educational attainment, organizational and commercial skills and technological congruence—the appropriateness of the leader's technology to the follower's economy—determine a country's potential to catch-up (Abramovitz 1986; 1995). It follows that $\sigma_1 > 0$ and $\sigma_2 > 0$ in Equation (2.6), capture the appropriateness of imported technology and other factors that determine absorptive capacity.

Substitution of Equations (2.4), (2.5) and (2.6) into Equation (2.3) yields the rate of growth of the technological gap.[6]

$$g = (\rho_f - \rho_h) + \left(\lambda_f z - \left(\sigma_1 G - \sigma_2 G^2\right) y_{BP}\right) \tag{2.7}$$

non-linearity that my reduce the induced technology parameter.

[6]Equation (2.7) shows that the balance of payments constraint is asymmetrical between the foreign and the home country and ergo, z rather than the foreign country's balance of payments constrained growth rate is employed.

2.2.3 Extended Balance of Payments Constrained Growth Model

This section builds on the scholarship that demonstrates how capital inflows can relax the balance of payments constraint and thus, increase the rate of economic growth consistent with balance of payments equilibrium (Thirlwall and Hussain 1982; Moreno-Brid 1998; Eliiott and Rhodd 1999; Barbosa-Filho 2001; Moreno-Brid 2003; Vera 2006; Alleyne and Francis 2008). The principal contribution here relaxes the assumption of constant terms of trade to demonstrate the idea that capital inflows can have *ambiguous* effects on the balance of payments constrained (BPCG) rate. The model presented here is closer to Thirlwall and Hussain (1982) since no restriction is imposed on the rate of growth of capital inflows (c). To prevent explosive external debt dynamics, several studies have imposed a range of restrictions: 1. Capital inflows are held constant, 2. Capital inflows are assumed to be a fixed proportion of domestic income, exports and imports (Moreno-Brid 1998; Dutt 2003; Alleyne and Francis 2008). It is not the objective of this chapter to analyze external debt dynamics, so the present model abstracts away from these complications. It is sufficient to assume here that the home country cannot infinitely finance its current account deficit and that in the long-run, the rate of change of net capital inflows is zero.

The balance of payments identity is given by:

$$P_h X + P_h C = P_f M \tag{2.8}$$

where $C > 0$ is net capital inflows; P_h, X, P_f, M are the home country's price level, export demand, the foreign country's price level and the home country's import demand respectively.

In growth rate form, where lower cases indicate rates of change:

$$\theta(p_h + x) + (1-\theta)(p_h + c) = p_f + m \tag{2.9}$$

where $\theta = (P_h X)/(P_f M)$ and $(1-\theta) = P_h C/(P_f M)$; $0 < \theta < 1$. In other words, θ and $(1-\theta)$ represent the share of imports funded by exports and capital inflows respectively.

The export demand function is given by Equation (2.10), where Z represents income in the foreign country. The parameters $\alpha < 0$ and $\beta > 0$ are the price and income elasticities of export demand respectively.

$$X = \left(\frac{P_h}{P_f}\right)^{\alpha} Z^{\beta} \tag{2.10}$$

In growth rate form:

$$x = \alpha(p_h - p_f) + \beta z \tag{2.11}$$

Import demand assumes the following specification, where the parameters $\gamma < 0$ and $\varepsilon > 0$ are the price and income elasticities of import demand respectively. The home country's level of income is given by Y.

$$M = \left(\frac{P_f}{P_h}\right)^{\gamma} Y^{\varepsilon} \tag{2.12}$$

In growth rate form:

$$m = \gamma(p_f - p_h) + \varepsilon y \tag{2.13}$$

Assume that a representative firm in the home country adds a mark-up (T) to its unit labour cost (ULC) as follows:[7]

$$P_h = T\left(\frac{W}{a}\right) \tag{2.14}$$

In turn, inflation in the home country evolves as shown below:

$$p_h = \tau + w - \hat{a} \tag{2.15}$$

where τ, w and $\hat{a}$ are the growth rate of the mark-up factor, nominal wages and labour productivity respectively. Assume that the mark-up factor is constant so that $\tau = 0$. This implies that inflation is a positive function of the growth rate of unit labour cost (ulc) or the extent by which wage growth exceeds productivity growth.

$$p_h = ulc = w - \hat{a} \tag{2.16}$$

Let nominal wage growth be defined as a simple function of output growth and autonomous wage growth $(\nu_0 > 0)$. This modeling approach envisions that the labour market gets tighter as economic growth accelerates, which increases labour's bargaining power and nominal wage demand (Stockhammer 2011). Autonomous wage growth (ν_0) can represent labour market in-

[7]This mark-up pricing approach is consistent with the empirical evidence on firms' behavior (Hall and Hitch 1939; Hall et al. 1996; Fabiani et al. 2006).

stitutions, say union power that affects nominal wage growth independent of labour market conditions.

$$w = \nu_0 + \nu_1 y \tag{2.17}$$

In turn, labour productivity grows as follows:

$$\hat{a} = \mu_0 - \mu_1 g - \mu_2 c \tag{2.18}$$

where $\mu_0 > 0$ is autonomous growth in labour productivity and g is the rate of growth of the technological gap between the foreign and the home country. Equation (2.18) says that productivity growth is negatively related to the rate of growth of the technological gap and capital inflows. The motivation behind an inverse relationship between $\hat{a}$ and g is straightforward. As the rate of growth of the technological gap increases, the home country drifts farther away from the technological frontier, which undermines its technological know-how or labour productivity. In other words, as g increases, the home country moves leftwards along the continuum of complex goods. As Andreoni (2014) and Bellandi et al. (2018) argue, the process of learning and unlearning depend on the cognitive structure embedded in the technological intensity of the production structure, so that a leftward movement along the continuum of complex goods reduce productivity growth. Moreover, as Verdoorn (1949) and Kaldor (1966) demonstrate, the productivity effects of learning by doing (Arrow 1962) and overall productivity growth are stronger in manufacturing activities or technologically complex economic activities. An important mechanism is that technology-intensive commodities provide for a more extensive division of labour, which increases productivity growth (Smith 2003). The central implication is that as g increases, both economic complexity and productivity growth are reduced. Further, this theoretical formulation is consistent with the modeling approach in North-South models that demonstrate how changes in the technological gap can produce new patterns of specialization and productivity growth (Porcile and Spinola 2018; Cimoli and Porcile 2014; 2010).[8]

[8] See Reinert (1995) for a wealth of historical evidence that show how productivity grows faster in the production of high quality or technologically complex economic activities. For recent empirical evidence, consult Romero and McCombie (2018); Romero and Britto (2017); Magacho and McCombie (2017b); Romero and McCombie (2016a;b). For example, Romero and McCombie (2016a) find evidence that high-technology manufacturing industries exhibit larger degrees of returns to scale than low-technology manufacturing industries. Their empirical study uses data from the EU KLEMS database, covering a sample of 12 manufacturing industries in 11 OECD countries over the period 1976-2006. Similar results are obtained in Romero and Britto (2017) and their

Why should capital inflows reduce the rate of growth of labour productivity? The basic hypothesis is that capital inflows reduce the rate of production transformation along the continuum of complex commodities and this undermines productivity growth. This formulation is similar to the Dutch Disease effect, where capital inflows appreciate the domestic currency and undermine the manufacturing sector, which deteriorates the production structure and productivity growth (Botta 2017). But since the home country does not have an independent currency the mechanisms are different. Capital inflows toward the technological laggard seek the highest private returns and this necessarily means investment in low-risk and low-technology commodities in the home country. The accompanying effects can support a boom in what Tregenna (2014) calls circulatory services—a growth in services unrelated to commodity production—and generate new lock-in effects biased towards lower-technology economic activities, which in turn reduce productivity growth through the mechanisms outlined above.

Why should capital flow toward the technological laggard—the home country?[9] In an EMU where financial markets are integrated, foreign exchange rate risks are eliminated, fiscal and debt limits are stringent and interest rates converge between the technological leader and laggard—as assumed in this chapter—the creditworthiness of the home country increases and produces a form of Keynesian animal spirits in financial markets. Consequently, borrowing costs fall in the home country, perceived risks decline and the rate of capital inflows increases.[10]

Substitution of Equations (2.17) and (2.18) into Equation (2.16) derives the home country's extended inflation rate:

$$p_h = \nu_0 + \nu_1 y - \mu_0 + \mu_1 g + \mu_2 c \tag{2.19}$$

In turn, the substitution of Equations (2.11), (2.13) and (2.19) into Equation (2.9)—the balance of payments identity—derives the extended balance of payments constrained growth rate (y_{BP}):

$$y_{BP} = \frac{\theta z \beta + (1-\theta)c + (1+\theta\alpha+\gamma)(\nu_0 - \mu_0 + \mu_1 g + \mu_2 c - p_f)}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1} \tag{2.20}$$

where $(1+\theta\alpha+\gamma) < 0$ is the extended Marshall-Lerner condition that guarantees an in-

finding is robust to controls such as research intensity (R&D expenditure) and various econometric methods.

[9]The empirical evidence at the level of the world economy shows that capital flows toward richer and more technologically advanced countries (Goktan 2015; Lucas 1990).

[10]See Lane (2013) for evidence of capital flows toward the technological laggards in the case of the Eurozone.

crease in price competitiveness spurs economic growth. Note that if there are no capital inflows ($\theta = 1$) and the Marshall-Lerner condition does not hold $(1+\theta\alpha+\gamma) = 0$, then Equation (2.20) becomes Thirlwall's Law ($y_{BP} = z\beta/\varepsilon$) (Thirlwall 1979).[11] Thirlwall's Law states that a country's long-run rate of growth—consistent with balance of payments equilibrium—is determined by the growth of external demand (foreign country's demand) and the ratio of its foreign trade elasticities (β/ε). Thirlwall argues that non-price competitiveness is reflected in these elasticities, in turn determined by technological capabilities. Further, as noted by Blecker (2013), Thirlwall's Law is based on the assumption that domestic expenditures must alway expand or contract to prevent the accumulation of reserves or external deficits respectively.

The balance of payments constrained growth rate can be disaggregated into the following components:

1. Real terms of trade effect $[\nu_0 - \mu_0 + \mu_1 g + \mu_2 c - p_f/\varepsilon - (1+\theta\alpha+\gamma)\nu_1]$

2. Real terms of trade effect combined with the weighted price elasticities of exports and imports $[(1+\theta\alpha+\gamma)(\nu_0 - \mu_0 + \mu_1 g + \mu_2 c - p_f)/\varepsilon - (1+\theta\alpha+\gamma)\nu_1]$

3. Income elasticity of import demand effect combined with the weighted price elasticities of exports and imports $[\varepsilon - (1+\theta\alpha+\gamma)\nu_1]$

4. Weighted growth of capital inflows $[(1-\theta)c + (1+\theta\alpha+\gamma)(\mu_2 c)/\varepsilon - (1+\theta\alpha+\gamma)\nu_1]$

5. Weighted growth in foreign demand $(\theta\beta z/\varepsilon - (1+\theta\alpha+\gamma)\nu_1)$.

Components (1) and (2) reproduce the standard results in the balance of payments constrained growth literature but with a twist. Similar to Thirlwall and Dixon (1979) and Ribeiro et al. (2017b), the model endogenizes domestic prices as a function of productivity growth but unlike these models, it also incorporates the growth rate of capital inflows as a determining factor. This approach to modeling price competitiveness undermines the well-established dichotomy of price and non-price competitiveness—it demonstrates that these are more interrelated than originally understood. Some variants of the balance of payments constrained growth model neatly separate price and non-price competitiveness into the price and income elasticities respectively. Other approaches either endogenize the trade elasticities (Ribeiro

[11] This law reflects Harrod's foreign trade multiplier or Hicks' supermultiplier in a dynamic context, see Thirlwall (1979) and Thirlwall and Hussain (1982).

et al. 2016; Cimoli and Porcile 2014) or include the technological gap as an argument in the export and import demand functions (Porcile et al. 2007; Amable and Verspagen 1995; Fagerberg 1988). The approach adopted in this chapter is similar to the work of Dosi et al. (2010). These scholars show that technological change can have both short- and long-run growth effects and that demand management is central to smooth output fluctuations, which in turn increases the rate of technical change. The central idea here is that changes in the technological gap do not simply affect trade specialization and the ratio of trade elasticities but also the calculus of price competitiveness.

This contribution has a number of implications. First, it can shed light on the intense debate regarding the role of unit labour costs in driving intra-Eurozone current account imbalances.[12] To put it succinctly, the Eurozone core, Germany in particular, may appear price competitive partly because of its super technological capabilities.[13] Alternatively, it can be said that the Eurozone periphery has lost price competitiveness partly because of a deterioration in their production structures. Third, it contributes to the debate on the so-called elasticity pessimism[14] and adds intellectual support to export-led growth models[15] regarding the debate on the role of relative prices in economic growth. Relative prices matter for economic growth to the extent that they are determined by non-price factors, i.e. technological change.

This chapter makes two additional contributions to the literature by way of components (3) and (4). Component (3) says that when the Marshall-Lerner condition holds, the higher the coefficient of induced wage growth (v_1), the lower the balance of payments constrained growth rate. The principal mechanism is through the income elasticity of import demand. This implies that the labour market can influence y_{BP} independent of income. The final contribution relates to the class of balance of payments constrained growth models that incorporate capital inflows. Unlike the standard formulation, component (4) says that capital inflows

[12] Numerous commentators explain Germany's export surplus on account of wage restraint and others simultaneously blame wage inflation in the periphery for their external deficits; see Stockhammer et al. (2015) for an overview of this debate.

[13] For evidence on Germany's technological advantage over the Eurozone periphery, consult Constantine (2017b), Storm and Naastepad (2015b), Botta (2014), Simonazzi et al. (2013) and Reinstaller et al. (2012).

[14] Proponents of export-led growth models stress the value of changes in relative price competitiveness, driven by endogenous technological change as the source of export success. However, scholars in the tradition of the balance of payments constrained growth model, contend that such changes dissipate in the long-run (elasticity pessimism).

[15] See Setterfield (2002; 1997); Setterfield and Cornwall (2002); Dixon and Thirlwall (1975) for formal models of export-led growth, which emphasize the role of relative prices in the growth process.

have ambiguous effects on the balance of payments constrained growth rate. As explained earlier, this ambiguity arises because of the negative effects capital inflows can have on the home country's production structure. As such, this chapter presents a new channel of how capital inflows may reduce an economy's balance of payments constrained growth rate. Under what conditions do the negative effects of capital inflows outweigh the positive effects? This chapter proposes that the wider the technological gap between the home and the foreign country, the more likely capital inflows reduce the balance of payments constrained growth rate. In the case where the technological gap is initially small, capital inflows can profitably fund medium- to high-technology economic activities and accelerate y_{BP}.

A handful of scholarship within the balance of payments constrained growth framework do emphasize the growth-reducing effects of capital inflows but these works focus on the debt and foreign currency crises channels (Filho et al. 2013; Vera 2006; Curado and Porcile 2002). For example, Filho et al. (2013) and Curado and Porcile (2002) argue that faster capital inflows expose an economy to sudden stops and lead to debt accumulation and high interest payments, which constrain economic growth. Vera (2006) presents an interesting model of financial transfers and trade imbalances, where the asymmetric North and South are interdependent. Vera finds that net interest payments from the indebted South produce both contractionary and expansionary growth regimes depending on parameter values. These studies along with Alleyne and Francis (2008), Moreno-Brid (2003) and Barbosa-Filho (2001) illustrate how capital inflows can reduce y_{BP} through debt repayment. It follows that the channel advanced in this chapter is closer to the Dutch Disease mechanism but within the context of an EMU and a balance of payment constrained growth model (Botta 2017; Rajan and Subramanian 2011; Paldam 1997).

The final contribution relates to component (5), where the growth in foreign demand is now weighted by the share of imports funded by exports (θ) and the weighted trade elasticities, particularly, the weighted income elasticity of import demand ($\varepsilon - (1+\theta\alpha+\gamma)\nu_1$). Unlike other formulations of extended balance of payments constrained growth models, this result shows that the growth effects of foreign demand are lower due to the weighted price elasticities of export and import demand.

2.3 Equilibrium I

Given the rate of growth of the technological gap and the extended balance of payments constrained growth rate, a system of two Equations is formed and they are reproduced below. Equation (2.21a) is the rate of growth of the technological gap, henceforth, the technology regime (TR) and Equation (2.21b) is the extended balance of payments constrained growth rate, henceforth, the balance of payments regime (BP).

$$TR : y_{BP} = \frac{\lambda_f z - g + (\rho_f - \rho_h)}{\sigma_1 G - \sigma_2 G^2} \tag{2.21a}$$

$$BP : y_{BP} = \frac{\theta z \beta + (1-\theta)c + (1+\theta\alpha+\gamma)(\nu_0 - \mu_0 + \mu_1 g + \mu_2 c - p_f)}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1} \tag{2.21b}$$

Equating Equations (2.21a) and (2.21b) yields the equilibrium rate of growth of the technological gap (g^*):

$$g^* = (\rho_f - \rho_h) + z\Big(\lambda_f - \big(\sigma_1 G - \sigma_2 G^2\big)\frac{\theta\beta}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1}\Big)$$

$$-\big(\sigma_1 G - \sigma_2 G^2\big)\Big(\frac{(1-\theta)c}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1}\Big)$$

$$+\big(\sigma_1 G - \sigma_2 G^2\big)\Big(\frac{(1+\theta\alpha+\gamma)(\nu_0 - \mu_0 + \mu_2 c - p_f)}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1}\Big) \tag{2.22}$$

The dynamics of the technological gap can be disaggregated into the following key components:

1. The difference in autonomous growth in technology $(\rho_f - \rho_h)$
2. Induced technological change in the frontier country $(\lambda_f z)$
3. The weighted Thirlwall's Law $\big[(\sigma_1 G - \sigma_2 G^2)\theta\beta z/\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1\big]$
4. The weighted growth of capital inflows $\big[-(\sigma_1 G - \sigma_2 G^2)(1-\theta)c + (\sigma_1 G - \sigma_2 G^2)(1+\theta\alpha+\gamma)(\mu_2 c)/\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1\big]$

5. The size of the initial technological gap $(\sigma_1 G - \sigma_2 G^2)$.

When $z = 0$ and $G = 0$, it is transparent that the evolution of g^* depends on the difference in autonomous technological change. The rate of change of the technological gap increases, decreases or remains the same depending on the following conditions:

$$g^* \begin{cases} > 0 \Rightarrow (\rho_f - \rho_h) > 0 & \text{Divergence Effect} \\ = 0 \Rightarrow (\rho_f - \rho_h) = 0 & \text{Neutral Effect} \\ < 0 \Rightarrow (\rho_f - \rho_h) < 0 & \text{Convergence Effect} \end{cases}$$

Now assume that $\rho_f - \rho_h = 0$; $c = 0$; $\theta = 1$ and $(1 + \theta\alpha + \gamma) = 0$. When these assumptions hold, a faster rate of growth in the foreign country produces both convergence and divergence effects. As the foreign country's rate of output growth increases, the rate of growth of the technological gap rises on account of the foreign country's Kaldor-Verdoorn effect (λ_f). The growth effects that promote technological divergence is referred to as the Kaldor-Verdoorn effect (Caldentey and Ali 2011). Simultaneously, faster growth in the foreign country increases the home country's balance of payments constrained growth rate and narrows the technological gap through the weighted Thirlwall's Law: $\left[(\sigma_1 G - \sigma_2 G^2)\beta z/\varepsilon\right]$. The convergence effect relating to faster growth in the home country is referred to as the Thirlwall effect (Caldentey and Ali 2011). It is clear that the strength of the Thirlwall effect depends non-linearly on the size of the technological gap. This implies that the convergence effect increases with G up to the critical point of $\sigma_1 - 2\sigma_2 G$, after which the convergence effect decreases. Accordingly, the Thirlwall effect is stronger when the initial gap is within the *convergence range* and the follower economy has sufficient capabilities to absorb technological spillovers. This is a fundamental insight. Integrating economies with technological gaps that exceed the critical point of $\sigma_1 - 2\sigma_2 G$, lowers the convergence effects. Recall the assumptions of strong limits on fiscal expenditure in the EMU and the absence of a fiscal union, so that countries with large technological gaps are unable to undertake industrial and technological policies to build absorptive capabilities. Economic and Monetary Unions with such design framework can promote technological divergence.[16] Given the divergence and convergence effects associated with faster output growth in the foreign country, the dynamics of the technological gap depend on the difference between the Kaldor-Verdoorn and weighted Thirlwall effects. When the assump-

[16]The Eurozone's design flaws relating to fiscal and monetary policy are excellent examples of how an EMU's design flaws can promote asymmetries (Stiglitz 2017; De Grauwe 2015; Stockhammer et al. 2015).

tions of $c = 0$ and $(1+\theta\alpha+\gamma) = 0$ are relaxed, the model allows for the influences of capital inflows and relative prices on the Thirlwall effect. Therefore:

$$g^* \begin{cases} > 0 \Rightarrow z\left(\lambda_f - \left(\sigma_1 G - \sigma_2 G^2\right)\frac{\theta\beta}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) > 0 & \text{Divergence Effect} \\ = 0 \Rightarrow z\left(\lambda_f - \left(\sigma_1 G - \sigma_2 G^2\right)\frac{\theta\beta}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) = 0 & \text{Neutral Effect} \\ < 0 \Rightarrow z\left(\lambda_f - \left(\sigma_1 G - \sigma_2 G^2\right)\frac{\theta\beta}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) < 0 & \text{Convergence Effect} \end{cases}$$

Note that a higher θ increases the convergence effect but a higher induced wage growth (ν_1) and productivity-technological gap effect (μ_1) lower the Thirlwall effect.

To focus on the effects of capital inflows independent of the Thirlwall effect, assume that $z = 0$. It is immediately evident that faster growth of capital inflows produces both convergence and divergence effects. This is illustrated by the negative and positive signs of the home country's induced technology parameters: $-(\sigma_1 G - \sigma_2 G^2)$ and $+(\sigma_1 G - \sigma_2 G^2)$. These result arise because of the ambiguous effects capital inflows have on the balance of payments constrained growth rate. This result is unlike the finding in Caldentey and Ali (2011) and the convergence literature (Blanchard and Giavazzi 2002), where capital inflows produce unambiguous convergence effects. The dynamics of the technological gap are given by:

$$g^* \begin{cases} > 0 \Rightarrow -\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1-\theta)c}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ +\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\nu_0-\mu_0+\mu_2 c-p_f)}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) > 0 & \text{Divergence Effect} \\ = 0 \Rightarrow -\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1-\theta)c}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ +\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\nu_0-\mu_0+\mu_2 c-p_f)}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) = 0 & \text{Neutral Effect} \\ < 0 \Rightarrow -\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1-\theta)c}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ +\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\nu_0-\mu_0+\mu_2 c-p_f)}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) < 0 & \text{Convergence Effect} \end{cases}$$

Note that the effects of capital inflows are weighted by the size of the initial technological gap. This implies that both the positive and negative effects of capital inflows are lower when the technological gap exceeds the critical point $(\sigma_1 - 2\sigma_2 G)$.

When all assumptions are relaxed, the rate of growth of the technological gap depends on the following conditions:

$$g^* \begin{cases} >0 \Rightarrow (\rho_f-\rho_h)+z\left(\lambda_f-\left(\sigma_1 G-\sigma_2 G^2\right)\frac{\theta\beta}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ -\left(\sigma_1 G-\sigma_2 G^2\right)\left(\frac{(1-\theta)c}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ +\left(\sigma_1 G-\sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\nu_0-\mu_0+\mu_2 c-p_f)}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right)>0 & \text{Divergence Effect} \\ =0 \Rightarrow (\rho_f-\rho_h)+z\left(\lambda_f-\left(\sigma_1 G-\sigma_2 G^2\right)\frac{\theta\beta}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ -\left(\sigma_1 G-\sigma_2 G^2\right)\left(\frac{(1-\theta)c}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ +\left(\sigma_1 G-\sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\nu_0-\mu_0+\mu_2 c-p_f)}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right)=0 & \text{Neutral Effect} \\ <0 \Rightarrow (\rho_f-\rho_h)+z\left(\lambda_f-\left(\sigma_1 G-\sigma_2 G^2\right)\frac{\theta\beta}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ -\left(\sigma_1 G-\sigma_2 G^2\right)\left(\frac{(1-\theta)c}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \\ +\left(\sigma_1 G-\sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\nu_0-\mu_0+\mu_2 c-p_f)}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right)<0 & \text{Convergence Effect} \end{cases}$$

2.3.1 Stability Analysis I

This section analyzes the stability of the equilibrium rate of growth of the technological gap, when the TR and BP regimes intersect.

$$TR : y_{BP} = \frac{\lambda_f z - g + (\rho_f - \rho_h)}{(\sigma_1 G - \sigma_2 G^2)}$$

$$BP : y_{BP} = \frac{\theta z\beta + (1-\theta)c + (1+\theta\alpha+\gamma)(\nu_0 - \mu_0 + \mu_1 g + \mu_2 c - p_f)}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1}$$

In $y_{BP} - g$ space, the TR and BP curves are downward sloping and stability requires that the slope of the TR curve is steeper than the BP curve. Formally, the condition for stability is given by (2.23a) and as noted in Blecker (2013), provided that there is not too much cumulative causation, the system solves for a unique and stable equilibrium (Figure 2.2a).

$$\frac{-1}{(\sigma_1 G - \sigma_2 G^2)} > \frac{(1+\theta\alpha+\gamma)\mu_1}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1} \tag{2.23a}$$

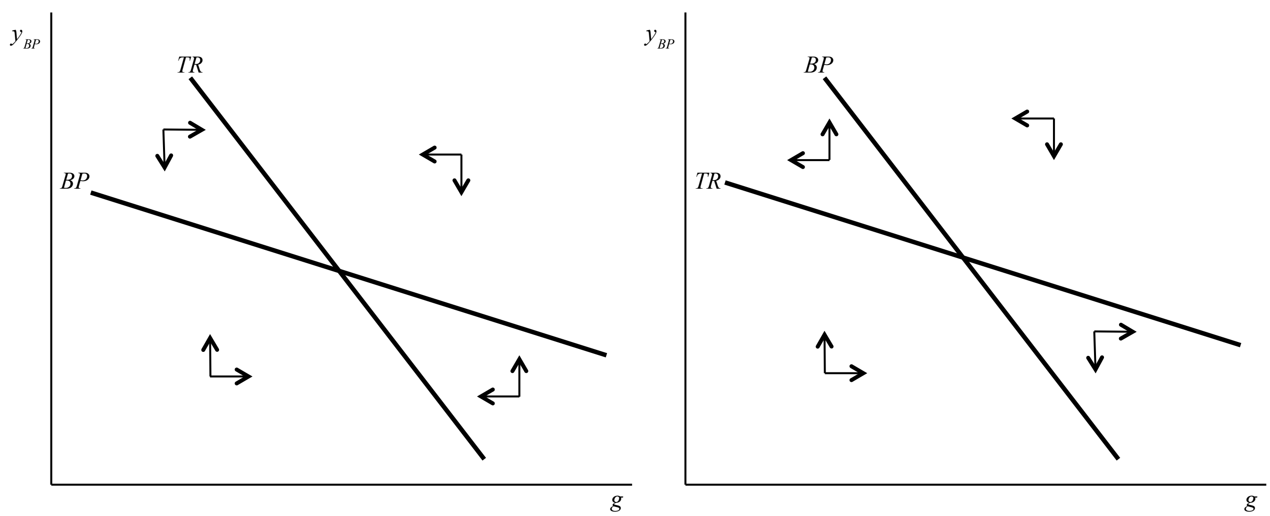
The unstable equilibrium is illustrated in Figure 2.2b, where the TR curve is flatter than the BP curve or the stability condition is not realized. Formally,

$$\frac{-1}{(\sigma_1 G - \sigma_2 G^2)} < \frac{(1+\theta\alpha+\gamma)\mu_1}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1} \tag{2.23b}$$

In the comparative dynamic analyses that follow, this chapter assumes that a unique and stable equilibrium exists and accordingly, rules out the possibility of an explosive technological convergence or divergence between countries.

Figure 2.2: Stability Analysis I

(a) Stable Equilibrium **(b)** Unstable Equilibrium



2.3.2 Comparative Dynamics I

This section explores three comparative dynamics: 1. A positive demand shock, 2. A positive shock to net capital inflows. and 3. A positive shock to the income elasticity of exports. The relevant partials for g^* are shown below, where the mathematical expression (2.24a) shows the ambiguous effects of an increase in z on the rate of change of the technological gap. The mathematical expression (2.24b) presents similarly ambiguous results for an increase in c. The mathematical relation in (2.24c) illustrates that the rate of growth of the technological gap decreases as the income elasticity of exports (β) increases.

$$g_z^* = \left(\lambda_f - \left(\sigma_1 G - \sigma_2 G^2\right)\frac{\theta\beta}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right) \tag{2.24a}$$

$$g_c^* = -\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1-\theta)}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1}\right)$$

$$+\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\mu_2)}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1}\right) \quad (2.24b)$$

$$g_\beta^* = -\left(\sigma_1 G - \sigma_2 G^2\right)\frac{\theta}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1}\Big) \quad (2.24c)$$

These partials imply the following for the TR and BP regimes. The mathematical relations in (2.25a) and (2.25b) demonstrate that the ambiguous results of g_z^* depend on the size of these effects.

$$TR_z = \frac{\lambda_f}{(\sigma_1 G - \sigma_2 G^2)} \quad (2.25a)$$

$$BP_z = \frac{\theta\beta}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1} \quad (2.25b)$$

Similarly, recalling that $(1+\theta\alpha+\gamma) < 0$, the partial derivative in (2.25c) illustrates the ambiguous response of the BP regime to faster rates of growth of capital inflows. The relation in (2.25d) shows the positive response of the BP regime to an increase in the income elasticity of exports.

$$BP_c = \frac{(1-\theta)+(1+\theta\alpha+\gamma)\mu_2}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1} \quad (2.25c)$$

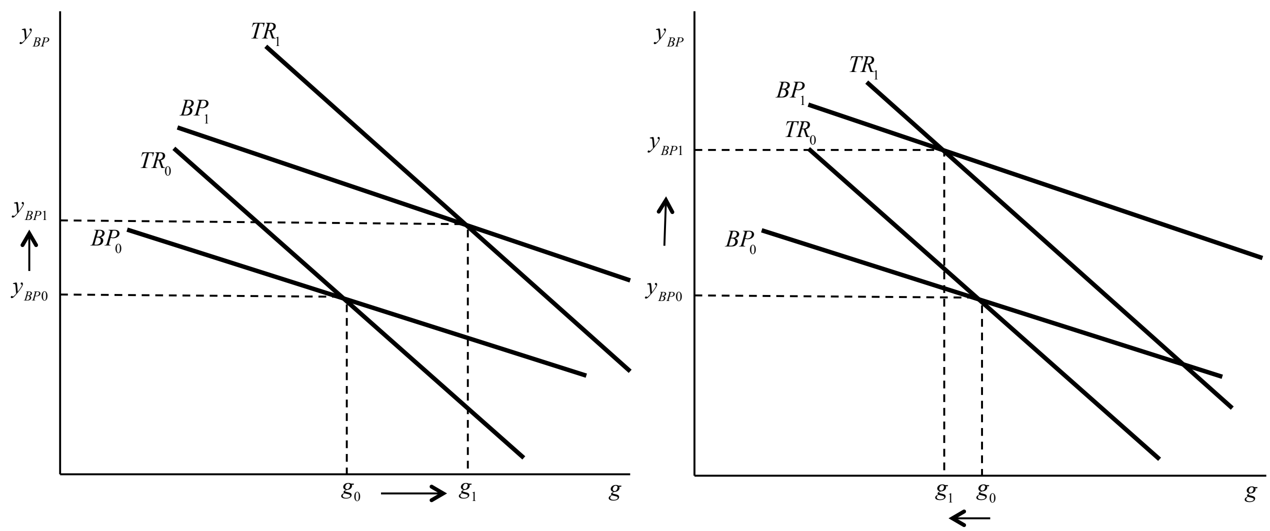
$$BP_\beta = \frac{\theta z}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1} \quad (2.25d)$$

2.3.2.1 Positive Demand Shock

This section presents the comparative dynamic results for an exogenous increase in the foreign country's rate of economic growth (z). Per the partials in (2.25a) and (2.25b), both the TR and BP regimes shift to the right, indicating an unambiguous increase in the balance of payments constrained growth rate. However, there are ambiguous effects on the rate of change of the technological gap. Figure 2.3a illustrates the case where the Kaldor-Verdoorn effect dominates the weighted Thirlwall effect, hence, technological divergence. Consider the initial equilibrium of $y_{BP0} - g_0$ associated with the $TR_0 - BP_0$ regimes. A positive shock to the growth rate of external demand produces the equilibrium solution of $y_{BP1} - g_1$ associated with the $TR_1 - BP_1$ regimes. It is obvious that a positive shock to z increases the balance of payments constrained growth rate from y_{BP0} to y_{BP1}. However, an acceleration in y_{BP} is insufficient to close the technological gap. In fact, the comparative dynamic results show that a faster rate of economic growth in the foreign country accelerates the rate of growth of the technological gap from g_0 to g_1. While faster output growth in the foreign country increases the rate of technological progress in the home country through its weighted Thirlwall's Law, technological progress grows faster in the foreign country because of its higher Kaldor-Verdoorn coefficient. This result has significant implications for members of Economic and Monetary Unions and regional groupings that aspire to deeper economic integration.

Figure 2.3: Growth in External Demand

(a) Technological Divergence **(b)** Technological Convergence



Growth with technological divergence is more likely when the initial technological gap exceeds the critical point of $\sigma_1 - 2\sigma_2 G$. It follows that a necessary condition for convergence in growth and technological capabilities is that members or potential members of an EMU must pass the litmus test of the maximum distance from the frontier country, as defined by $\sigma_1 - 2\sigma_2 G$. This comparative dynamic result also urges a rethink of the conception of convergence. The established view is that convergence requires faster rates of economic growth in the laggard economy, so that living standards can converge between core and periphery. For this reason, external imbalances and capital inflows are necessary conditions for convergence, whether at the level of an EMU or the world economy (Blanchard and Giavazzi 2002). But this approach to convergence omits the historical evidence that no core or developed economy improved its standard of living without building technological capabilities.[17] This chapter takes the view that convergence should mean the reduction of technological capabilities among participating countries, whether within an EMU or at the level of the world economy.

The result of economic growth with technological divergence also adds an interesting wrinkle to the policy recommendation of coordinated fiscal expansion at the level of the world economy, regional groupings and/or two-country settings with extensive trade linkages (Hein and Truger 2012; McCombie 1993). For example, in the case of the Eurozone, several scholars recommend expansionary fiscal policy in the Eurozone core (Germany) as a means to activate a Eurozone recovery (Hein and Truger 2017; Stockhammer et al. 2015; Stockhammer and Onaran 2012). The results presented here add support to this Keynesian policy package but also demonstrates how an economic recovery can be underpinned by a widening of the technological gap. It follows that the policy package must be one where Keynes meets Schumpeter (Dosi et al. 2010)—demand management in conjunction with industrial and technology policy.

In Figure 2.3b, the comparative dynamic results show that convergence in economic growth and technological capabilities are possible when the weighted Thirwall effect dominates the Kaldor-Verdoorn effect. Such a scenario is possible if the technological gap between the home and the foreign country is at or below the critical level of $\sigma_1 - 2\sigma_2 G$. This implies that technological spillovers from the frontier economy is maximized and that the home country has adequate absorptive capabilities to utilize these spillovers. In other words, these are the conditions for technological convergence.

The principal insight here is that asymmetric integration without any compensating technology policy at the country and/or community level can engender significant forces of technological divergence if the degree of technological asymmetry exceeds a critical threshold. This finding is robust even if the laggard economy benefits from strong growth in external demand.

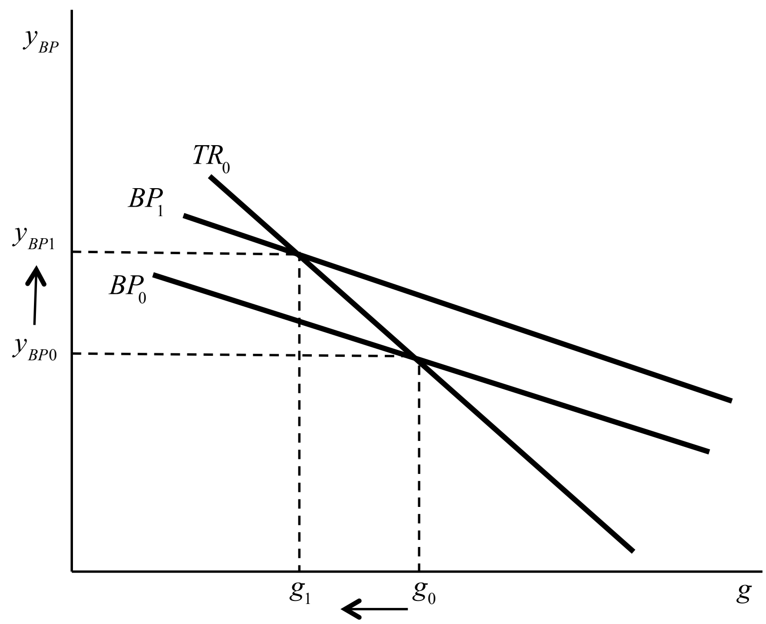
2.3.2.2 Positive Shock to the Income Elasticity of Exports

This section presents the comparative dynamic results of a positive shock to the home country's income elasticity of export demand (β). Consider Figure 2.4 where the initial equilibrium associated with $TR_0 - BP_0$ is $y_{BP0} - g_0$. A positive shock to β shifts the BP_0 regime upwards

[17] See Reinert (2008) and Reinert (1995) for an excellent survey on the economic history of technology policy and the role it played in improving living standards since the renaissance.

to BP_1, per the mathematical expression (2.25dc). This results in economic growth—y_{BP0} increases to y_{BP1}—and technological convergence—g_0 decreases to g_1. This finding demonstrates that growth and technological convergence is possible if the source of faster balance of payments constrained growth is technological change.[18] The key implication of this finding is that technology policy in laggard economies can serve as effective regional cohesion policies when a technological gap is binding among participating countries. This result provides strong justification for Regional Systems of Innovation, which focus on technological upgrading in laggard economies that participate in regional groupings, say, an EMU.[19]

Figure 2.4: Income Elasticity of Export Demand



2.3.2.3 Positive Shock to Net Capital Inflows

In this section, the author presents the ambiguous effects of net capital inflows on the balance of payments constrained growth rate and the evolution of the technological gap. To being with, consider the case where a positive shock to the rate of growth of capital inflows increases

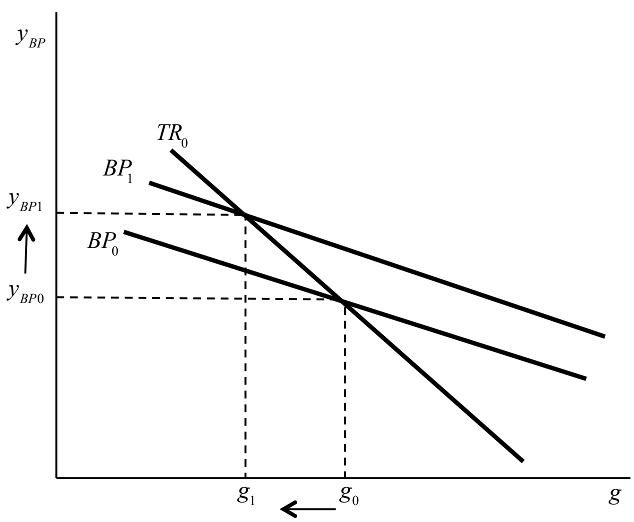
[18] Numerous studies have empirically verified that technological change increases non-price competitiveness as measured by the foreign trade elasticities (Gouvea and Lima 2010; Romero and McCombie 2016b; 2018; Cimoli et al. 2010; Martins Neto and Porcile 2017).

[19] A Regional System of Innovation is a territorially embedded institutional infrastructure and production system that creates and diffuses knowledge across a specified territory. See Doloreux (2002) for a discussion of this concept.

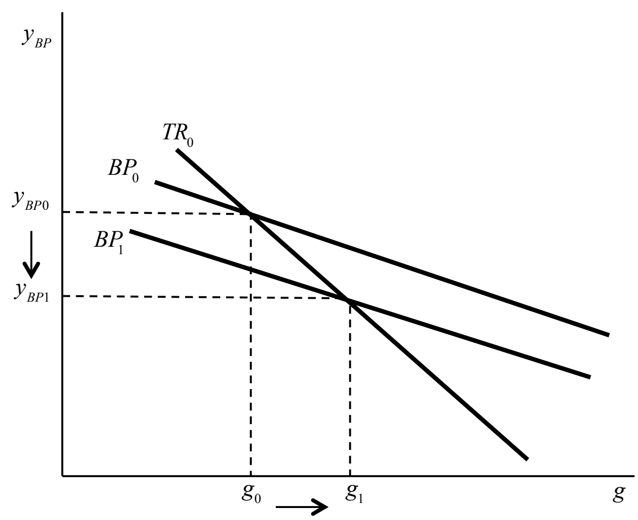
the home country's balance of payments constrained growth rate, Figure 2.5a. The initial equilibrium solution of $y_{BP0} - g_0$ is associated with $TR_0 - BP_0$. As c increases, the BP_0 regime shifts to the right and a new equilibrium solution of $y_{BP1} - g_1$ is derived at $TR_0 - BP_1$. These results show the case of a higher balance of payments constrained growth rate and technological convergence, as g_0 decreases to g_1. It can be inferred that faster rates of capital inflows produce unambiguous convergence effects. This is the case that numerous scholars have within their analytical frame and why many regard external imbalances and faster rates of growth in laggard economies as non-problematic.[20] However, this chapter argues that this result hinges on at least two conditions: 1. A small technological gap between frontier and laggard economy and 2. The home country is a learning society with sufficient absorptive capabilities. Under these conditions, technological catch-up is observed and external imbalances are simply transitory.

Figure 2.5: Net Capital Inflows

(a) Positive Effect on the BP Regime



(b) Negative Effect on the BP Regime



Now consider Figure 2.5b, the case where faster rates of growth of capital inflows reduce y_{BP}. The initial equilibrium solution is $y_{BP0} - g_0$ at $TR_0 - BP_0$. An exogenous increase in c shifts the BP regime from BP_0 to BP_1 and produces absolute divergence, in the sense of faster rates of technological divergence (g_1) and a lower balance of payments constrained growth rate (y_{BP1}). In this model, faster rates of capital inflows reduce the technological complexity

[20] For an example, see Blanchard and Giavazzi (2002).

of commodities and the rate of growth of labour productivity, which undermine cost competitiveness. The corresponding decline in the balance of payments constrained growth rate increases the rate of growth of the technological gap. It follows that external imbalances between countries with significant technological gaps, can produce a medium-run divergence in technological capabilities and economic performance. As explained earlier, this result is more likely when the home country has poor learning capacities and/or the initial technological gap exceeds the critical point that maximizes technological spillovers.

There are strong evidence in the case of the Eurozone to support the comparative dynamic results presented here. Several empirical studies show that the Eurozone periphery has lost value added share in medium- and high-technology exports since the introduction of the Euro (Storm and Naastepad 2015b; Botta 2014; Simonazzi et al. 2013; Reinstaller et al. 2012). Further, Storm and Naastepad (2015b) draw a clear causal link between rapid capital inflows toward the periphery and the deterioration of their production structures. Moreover, in a series of publications, Reinert and his co-authors contend that the European crisis can only be properly understood in the context of dramatic deindustrialization of the periphery, a direct consequence of abandoning the previous strategy of symmetrical integration based on Listian[21] principles (Reinert and Kattel 2019; Reinert 2019; Reinert and Kattel 2014). To the best of the author's knowledge, this is the first time these ideas are formalized.

2.4 Aggregate Demand Growth Rate

This section derives the growth rate of aggregate demand to analyze how capital inflows affect the dynamics of the technological gap and economic growth in different demand regimes. To derive the aggregate demand growth rate (y_{AD}), consider the standard macroeconomic relationship in the absence of government, where C, I and B are consumption, investment and net exports respectively.

$$Y = C + I + B \tag{2.26}$$

Let consumption demand be defined as

[21] Reinert (2019) emphasizes three Listian principles: 1. The preconditions for wealth, democracy and political freedom are based on a diversified manufacturing sector subject to increasing returns, 2. A nation first industrializes and is then gradually integrated into nations at the same level of development and 3. Economic welfare is a result of synergy—infrastructure, education and science.

$$C = C_0(\omega Y)^{\delta_1}(\Pi Y)^{\delta_2} \tag{2.27}$$

where C_0 is a constant and ω and Π are the wage and profit share respectively. The parameters δ_1 and δ_2 are the wage and profit share elasticities of consumption demand. It is assumed that workers do not save so that $\delta_1 = 1$ but capitalists do save a fraction of their income, which implies that $0 < \delta_2 < 1$.

In growth rate form:

$$c = \delta_1(\hat{\omega} + y) + \delta_2(\pi + y) \tag{2.28}$$

Recall that $ULC = W/a = \omega$, so that $ulc = \hat{\omega}$. Also, the rate of growth of the profit share is given by: $\pi = -\kappa ulc$, where $\kappa = ULC/1 - ULC > 0$.[22] Substitution into Equation (2.28) yields:

$$c = \delta_1(ulc + y) + \delta_2(-\kappa ulc + y) \tag{2.29}$$

Investment demand is modeled as a function of both demand and profit share, consistent with the approaches of Bhaduri and Marglin (1990) and Dutt (1984). Following Blecker (2002), it assumes the following functional form:

$$I = I_0(\Gamma^{\eta_1}\Pi^{\eta_2}Y^{\eta_3}) \tag{2.30}$$

where I_0 is a constant and Γ represents animal spirits. The parameters η_1, η_2 and η_3 are the elasticity of investment with respect to animal spirits, profit share and income (demand).

In growth rate form and after the substitution of $\pi = -\kappa ulc$, yields:

$$\hat{I} = \eta_1\hat{\Gamma} - \eta_2\kappa ulc + \eta_3 y \tag{2.31}$$

Given that $B = X - M$ and in rates of change, $b = x - m$. Recall:

$$x = \alpha(p_h - p_f) + \beta z$$

$$m = \gamma(p_f - p_h) + \varepsilon y$$

Thus, b yields:

[22] $1 = \Pi + ULC \rightarrow 0 = \pi\frac{\Pi}{\Pi + ULC} + ulc\frac{ULC}{\Pi + ULC} \rightarrow \pi = -ulc\frac{ULC}{\Pi + ULC}\frac{\Pi + ULC}{\Pi} = -\frac{ULC}{1 - ULC}ulc = -\kappa ulc.$

$$b = (\alpha + \gamma)(p_h - p_f) + \beta z - \varepsilon y \tag{2.32}$$

Recall that $ulc = p_h$ and after substitution yields:

$$b = (\alpha + \gamma)(ulc - p_f) + \beta z - \varepsilon y \tag{2.33}$$

The goods market equilibrium condition is given by:

$$Y = C + I + B$$

and in growth rate form:

$$y = \Phi_C c + \Phi_I \hat{I} + \Phi_B b \tag{2.34}$$

where $\Phi_i (i = C, I, B)$ denotes the income share of each aggregate demand component. Substitution of Equations (2.29), (2.31) and (2.33) into Equation (2.34), yields the rate of growth consistent with goods market equilibrium.

$$y_{AD} = \frac{\Phi_C\big(ulc - \delta_2 \kappa\, ulc\big) + \Phi_I(\eta_1 \hat{\Gamma} - \eta_2 \kappa\, ulc) + \Phi_B\big[(\alpha + \gamma)(ulc - p_f) + \beta z\big]}{1 - \Phi_C(1 + \delta_2) - \Phi_I \eta_3 + \Phi_B \varepsilon} \tag{2.35}$$

It order to understand the workings of the goods market equilibrium and the dynamics that follow, it maybe helpful to consider the partial effect of ulc on the rate of growth of aggregate demand.

$$y_{AD\,ulc} = \frac{\Phi_C(1 - \delta_2 \kappa) - \Phi_I \eta_2 \kappa + \Phi_B(\alpha + \gamma)}{1 - \Phi_C(1 + \delta_2) - \Phi_I \eta_3 + \Phi_B \varepsilon} \tag{2.36}$$

The partial derivative $y_{AD\,ulc}$ says that a rise in the rate of growth of unit labour cost has ambiguous effects on the growth rate of aggregate demand (recall that $\alpha + \gamma < 0$). This standard result produces either a wage-led or profit-led demand regime (Bhaduri and Marglin 1990). When $y_{AD\,ulc} > 0$, the demand regime is considered to be wage-led, while a profit-led demand regime emerges when $y_{AD\,ulc} < 0$. The basic intuition is that as the growth rate of unit labour cost rises, consumption demand increases at the expense of investment and net export demand and the corresponding net effect on demand growth depends on the relative strength of these effects.

Recall:

$$ulc = p_h = \nu_0 + \nu_1 y - \mu_0 + \mu_1 g + \mu_2 c$$

and after substitution into Equation (2.35) derives the extended aggregate demand growth rate:

$$y_{AD} = \frac{q_0 + q_1 g + q_2 c}{1 + \Phi_C(\delta_2 \kappa \nu_1 - \nu_1 - \delta_2 - 1) + \Phi_I(\eta_2 \kappa \nu_1 - \eta_3) + \Phi_B(\varepsilon - (\alpha + \gamma)\nu_1)} \tag{2.37}$$

where $q_0 = \Phi_C(\nu_0 - \mu_0) + \Phi_C \delta_2 \kappa(-\nu_0 + \mu_0) + \Phi_I \eta_1 \hat{\Gamma} + \Phi_I \eta_2 \kappa(-\nu_0 + \mu_0) + \Phi_B[(\alpha + \gamma)(\nu_0 - \mu_0 - p_f) + \beta z]$; $q_1 = (\Phi_C \mu_1 - \Phi_C \delta_2 \kappa \mu_1 - \Phi_I \eta_2 \kappa \mu_1 + \Phi_B \mu_1)$; $q_2 = \Phi_C \mu_2 - \Phi_C \delta_2 \kappa \mu_2 - \Phi_I \eta_2 \kappa \mu_2 + \Phi_B \mu_2$. Consistent with the partial $y_{AD\,ulc}$, partials $y_{AD\,g}$ and $y_{AD\,c}$ produce ambiguous results depending on the demand regime.

2.5 Equilibirum II

Given the derivation of the growth rate of aggregate demand and the TR and BP regimes, a system of three Equations is formed and are reproduced below. Equations (2.38a) and (2.38b) are the familiar technology and balance of payments regimes. Equation (2.38c) shows the aggregate demand regime (AD), the growth rate of aggregate demand consistent with goods market equilibrium. In other words, y_{AD} illustrates the short-run growth rate.

$$TR : y_{BP} = \frac{\lambda_f z - g + (\rho_f - \rho_h)}{(\sigma_1 G - \sigma_2 G^2)} \tag{2.38a}$$

$$BP : y_{BP} = \frac{\theta z \beta + (1-\theta)c + (1 + \theta\alpha + \gamma)(\nu_0 - \mu_0 + \mu_1 g + \mu_2 c - p_f)}{\varepsilon - (1 + \theta\alpha + \gamma)\nu_1} \tag{2.38b}$$

$$AD : y_{AD} = \frac{q_0 + q_1 g + q_2 c}{1 + \Phi_C(\delta_2 \kappa \nu_1 - \nu_1 - \delta_2 - 1) + \Phi_I(\eta_2 \kappa \nu_1 - \eta_3) + \Phi_B(\varepsilon - (\alpha + \gamma)\nu_1)} \tag{2.38c}$$

Equating Equations (2.38a), (2.38b) and (2.38c) yields the equilibrium rate of growth of the technological gap (g^{**}):

$$g^{**} = \frac{DH - q_0 - q_2 c}{q_1} \tag{2.38d}$$

where $D = (\rho_f - \rho_h) + z\Big(\lambda_f - \Big(\sigma_1 G - \sigma_2 G^2\Big)\frac{\theta\beta}{\varepsilon - (1+\theta\alpha+\gamma)\nu_1 - (1+\theta\alpha+\gamma)\mu_1}\Big)$

$-\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1-\theta)c}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right)+\left(\sigma_1 G - \sigma_2 G^2\right)\left(\frac{(1+\theta\alpha+\gamma)(\nu_0-\mu_0+\mu_2 c-p_f)}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1-(1+\theta\alpha+\gamma)\mu_1}\right)$ and $H = 1+\Phi_C(\delta_2\kappa\nu_1-\nu_1-\delta_2-1)+\Phi_I(\eta_2\kappa\nu_1-\eta_3)+\Phi_B(\varepsilon-(\alpha+\gamma)\nu_1$.

2.5.1 Stability Analysis II

This section analyzes the stability of the equilibrium rate of growth of the technological gap (g^{**}), when the TR, BP and AD regimes intersect. The mathematical expression in (2.39) shows that the partial y_{ADg} is ambiguous, it follows that the slope of the AD curve depends on the demand regime.

$$y_{ADg} = \frac{(\Phi_C\mu_1 - \Phi_C\delta_2\kappa\mu_1 - \Phi_I\eta_2\kappa\mu_1 + \Phi_B\mu_1)}{1+\Phi_C(\delta_2\kappa\nu_1-\nu_1-\delta_2-1)+\Phi_I(\eta_2\kappa\nu_1-\eta_3)+\Phi_B(\varepsilon-(\alpha+\gamma)\nu_1)} \tag{2.39}$$

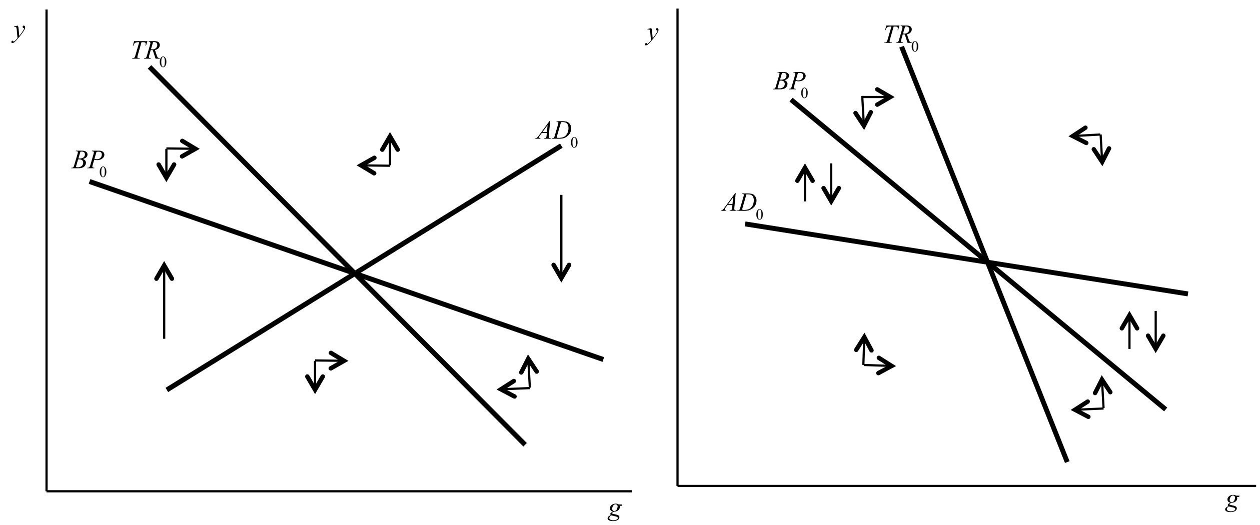
As the rate of growth of the technological gap increases, productivity growth declines (Equation 2.18) and the rate of growth of unit labour cost rises, per Equation (2.19). If the growth rate of AD increases ($y_{ADg} > 0$), then the demand regime is wage-led and the AD curve is upward sloping in $y-g$ space. However, if the growth rate of aggregate demand falls as g increases ($y_{ADg} < 0$), then the demand regime is profit-led and the AD curve is negatively sloped in $y-g$ space.

The stability of the equilibrium in both wage-led and profit-led demand regimes is illustrated in Figure 2.6, under the assumption that $-1/(\sigma_1 G-\sigma_2 G^2) > 1+\theta\alpha+\gamma)\mu_1/\varepsilon-(1+\theta\alpha+\gamma)\nu_1$ or the TR regime is steeper than the BP regime. It is transparent that the equilibrium in the wage-led demand regime in Figure 2.6a is a saddle point and thus, unstable. However, the equilibrium rate of growth of the technological gap is stable in the profit-led demand regime (Figure 2.6b).

The comparative dynamic analyses that follow focus exclusively on the partial effects of an increase in the rate of growth of capital inflows. The corresponding partials for the BP and AD regimes are shown below. As explained earlier, the growth rate of capital inflows has ambiguous effects on y_{BP} (2.40a)—recall that $(1+\theta\alpha+\gamma) < 0$—and as shown in (2.40b), the same holds for the growth rate of aggregate demand. This ambiguous result is driven by the different demand regimes. The precise mechanisms relate to Equations (2.18) and (2.19), where faster rates of capital inflows reduce productivity growth and increase the rate of growth of unit labour cost. When $y_{ADc} > 0$, the demand regime is wage-led and the growth rate of aggregate demand increases when c accelerates. Conversely, if $y_{ADc} < 0$, then the demand regime is

Figure 2.6: Stability Analysis II

(a) Unstable Equilibrium: Wage-led Demand **(b)** Stable Equilibrium: Profit-led Demand



profit-led and the short-run rate of growth declines as c increases.

$$y_{BPc} = \frac{(1-\theta)+(1+\theta\alpha+\gamma)\mu_2}{\varepsilon-(1+\theta\alpha+\gamma)\nu_1} \tag{2.40a}$$

$$y_{ADc} = \frac{\Phi_C\mu_2-\Phi_C\delta_2\kappa\mu_2-\Phi_I\eta_2\kappa\mu_2+\Phi_B\mu_2}{1+\Phi_C(\delta_2\kappa\nu_1-\nu_1-\delta_2-1)+\Phi_I(\eta_2\kappa\nu_1-\eta_3)+\Phi_B(\varepsilon-(\alpha+\gamma)\nu_1)} \tag{2.40b}$$

2.5.2 Comparative Dynamics II

2.5.2.1 Capital Inflows in a Wage-led Demand Regime

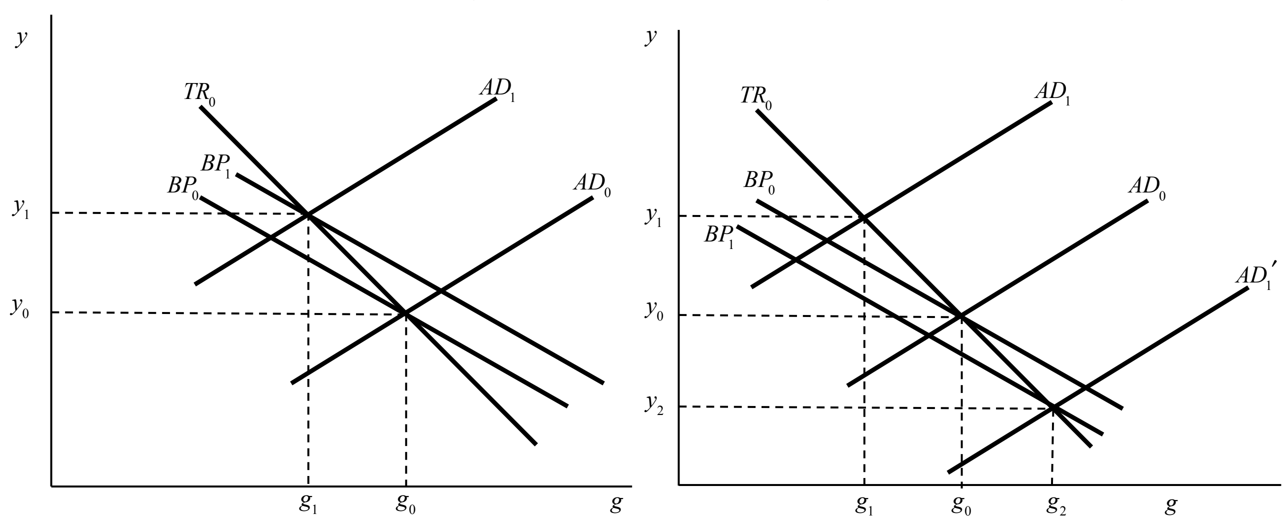
In this section the chapter analyzes how an increase in the rate of growth of capital inflows affects both short- and medium-run economic growth and the rate of change of the technological gap in a wage-led demand regime. Consider Figure 2.7a, where it is assumed that a faster rate of capital inflow increases the balance of payments constrained growth rate. The initial equilibrium solution of $y_0 - g_o$ is given by the $TR_0 - BP_0 - AD_0$ regimes. An exogenous increase in c shifts BP_0 upwards to BP_1 and simultaneously shifts the AD regime from AD_0 to AD_1. The results show that faster rates of capital inflow increase both the short- and medium-run rates of economic growth and promote technological convergence. These comparative dynamic results are similar to the findings in section 2.3.2 when capital inflows increase y_{BP}.

However, the results presented here also demonstrate that a faster rate of capital inflow increases the home country's short-run growth rate when its demand regime is wage-led. This case best illustrates the convergence hypothesis that the laggard economy with scarce capital and relatively high marginal returns, attracts capital inflows and converges to the frontier. It is important to emphasize that this result hinges on the singular condition that the technological gap between the laggard and the frontier economy does not exceed the critical value of $\sigma_1 - 2\sigma_2 G$. This condition places the laggard economy on its saddle path to produce a stable equilibrium. In plain terms, faster rates of capital inflows only increase the balance of payments constrained growth rate when the technological gap is within its convergence range. If this condition is not met, the equilibrium outcome is unstable and the rate of technological divergence accelerates until a crisis emerges.

Figure 2.7: Net Capital Inflows in a Wage-Led Demand Regime

(a) Positive Effect on the BP Regime

(b) Negative Effect on the BP Regime



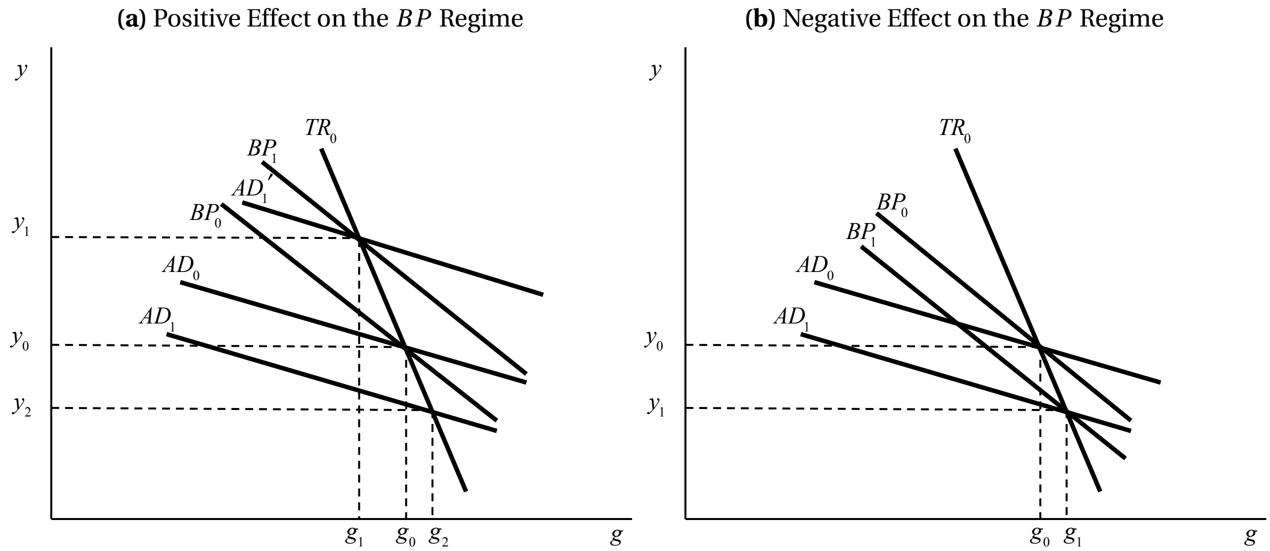
In Figure 2.7b, where an acceleration in the rate of growth of capital inflow reduces y_{BP}, the results differ. Consider the initial equilibrium solution of y_0–g_0 associated with the TR_0–BP_0–AD_0 regimes. An exogenous increase in c increases aggregate demand from AD_0 to AD_1 but the BP regime shifts downwards from BP_0 to BP_1. It is transparent that faster rates of capital inflow increase the growth rate of aggregate demand from y_0 to y_1 but reduce the balance of payments constrained growth rate from y_0 to y_2. Given the contraction in y_{BP}, the rate of growth of the technological gap increases from g_0 to g_1. This in turn reduces productivity growth and increases the rate of growth of unit labour cost. It follows that the growth rate of aggregate demand increases and moves further away from the medium-run equilibrium solution of $y_2 - g_2$ associated with the $TR_0 - BP_1$ regimes. No stable adjustment process exists and the ever increasing unit labour cost and demand growth can only be arrested by way of a financial crisis, e.g. when concerns about debt sustainability increase and animal spirits in financial markets wane. The standard consequences of a sudden stop are contraction in aggregate demand and economic growth but as these results illustrate, an additional levy is imposed by way of a widening of the technological gap. Such a result can be illustrated by a collapse in the AD regime from AD_1 to $AD_1{}'$.

One implication of these comparative dynamic results is that rapid output growth in the short-run can provide a false impression of convergence. The results presented here make the case that the relevant growth rate for convergence is the balance of payments constrained growth rate. Further, the results from Figure 2.7b aptly illustrate the dynamics of the Eurozone crisis. Rapid capital flows toward the Eurozone periphery led to significant growth in aggregate demand and unit labour cost, a deterioration in their production structures and a rise in external imbalances that eventually ended in a sudden stop of capital inflows (Storm and Naastepad 2015b). The corresponding contraction in actual growth rates has led to economic stagnation and as Figure 2.7b shows, the Eurozone periphery pays an additional cost in terms of a widening of the technological gap.

2.5.2.2 Capital Inflows in a Profit-led Demand Regime

In this section the author analyzes how an increase in the rate of growth of capital inflow affects economic growth and the rate of change of the technological gap in a profit-led demand regime. In Figure 2.8a, consider the initial equilibrium solution of $y_0 - g_0$, where faster rates of growth of capital inflow increase y_{BP}. An exogenous increase in c shifts the BP regime upwards from BP_0 to BP_1 but contracts demand growth from AD_0 to AD_1. The results show that faster rates of capital inflow produce short-run contractionary effects in a profit-led demand regime but increase the balance of payments constrained growth rate. The lower short-run output growth of y_2 must eventually adjust to the higher balance of payments constrained growth rate of y_1. The adjustment process is as follows. As c increases y_{BP}, technological convergence accelerates through the weighted Thirlwall effect and in turn, increases and reduces the growth rate of productivity and unit labour cost respectively. The higher profit share boosts the growth rates of investment and net external demand and consequently, increases the growth rate of aggregate demand. These adjustments take place until the new equilibrium is reached with a higher output growth of y_1 and a lower rate of technological divergence (g_1) at the $TR_0 - BP_1 - AD_1'$ regimes. According to these findings, faster rates of capital inflows do not unambiguously increase the growth rate of aggregate demand in the short-term—demand regimes matter. Notwithstanding a short-period contraction, if faster rates of capital inflows relax the balance of payments constraint, economies with profit-led demand regimes can experience faster output growth and technological convergence. As noted earlier, this result requires that the technological gap between the laggard and the frontier economy does not exceed the critical value of $\sigma_1 - 2\sigma_2 G$.

Figure 2.8: Net Capital Inflows in a Profit-Led Demand Regime



Now consider the initial equilibrium solution of $y_0 - g_0$ in Figure 2.8b, where faster rates of capital inflow reduce the balance of payments constrained growth rate. This implies that the technological gap between the laggard and the frontier economy exceeds the critical value of $\sigma_1 - 2\sigma_2 G$. An exogenous increase in c contracts both the AD and BP regimes, which reduce output growth from y_0 to y_1 and increase the growth rate of the technological gap from g_0 to g_1. It follows that faster rates of capital inflow produce medium-run divergence in economic performance and technological capabilities, when capital inflows deteriorate production structures in profit-led demand regimes. In this case, the short-run contraction becomes a medium-period stagnation and through lower induced technical change, engenders a widening of the technological gap. These comparative dynamic results are in stark contrast to the case in Figure 2.7b, where the divergence in technological capabilities is temporarily buttressed by a short-run economic boom. Therefore, demand regimes matter for how laggard economies transition to a growth path with a faster rate of technological divergence.

2.6 Conclusion

This study contributes to the literature on technological gaps and balance of payments constrained growth by developing a theoretical framework to account for the ambiguous effects of capital inflows on demand and balance of payments constrained growth. The model shows that when a technological gap exists between two countries in an Economic and Monetary Union (EMU) and it exceeds a critical threshold, capital flows toward the technological laggard deteriorate its production structure and reduce its balance of payments constrained growth rate. However, these results are reversed when the technological gap between countries falls within a convergence range. Capital flows are consequential to the catching-up process because the evolution of the technological gap depends on the Kaldor-Verdoorn effect.

It is noteworthy that the theoretical model relaxes the dichotomy of cost and non-cost competitiveness by illustrating the adverse effects capital inflows may have on a country's production structure. The chapter makes the case that changes in non-cost competitiveness due to production transformation, alter the rate of productivity growth and correspondingly, the growth rate of unit labour cost or cost competitiveness. It follows that cost and non-cost competitiveness are more complementary than traditionally understood.

The multitude of results obtained from the model contribute to the literature by illustrating the various conditions under which capital inflows can engender short-run booms and busts and technological convergence and divergence. The chapter demonstrates that capital inflows can produce a short-run economic boom in wage-led demand regimes but medium-run contraction and technological divergence when capital inflows deteriorate the production structure. However, when the initial technological gap is small and the laggard economy has sufficient absorptive capabilities, capital inflows relax the balance of payments constraint and promote convergence in technological capabilities and economic performance. But these results differ in profit-led demand regimes. When a significant technological gap exists and the demand regime is profit-led, capital inflows lead to stagnation in both the short- and medium-term and simultaneously widen the technological gap. In the case of a small technological gap, capital inflows only produce a short-run contraction, in the medium-term, economic performance improves and the rate of growth of technological convergence increases. These varying results show that demand regimes determine the response of short-run growth but whether a laggard economy converges to or diverges from the frontier country, depends on how capital inflows influence its balance of payments constrained growth rate.

These findings have significant implications for EMUs and other regional groupings that aspire to deeper economic integration. First, the initial size of the technological gap between frontier and laggard economy is the principal determinant of whether closer economic integration promotes convergence or divergence. It follows that potential members of EMUs must pass the litmus test that specifies the maximum distance a member country can be from the frontier economy. This approach to integration limits the possibility of technological polarization and therefore, maintains community cohesion. Second, the analytical results show that expansionary policy in the frontier country is inadequate to promote technological convergence when the initial technological gap is significant. Only technology policy in the laggard economy can promote technological convergence.

Chapter 3

Fiscal Policy, Distribution and BOP-Dominated Technological Change

3.1 Introduction

This chapter makes the case that five conditions are sufficient to produce technological polarization between members of an Economic and Monetary Union (EMU). First, a technological gap must exist between countries, second, the laggard economy must have a more unequal distribution of income, third, there must be no fiscal union that governs the EMU, fourth, the laggard economy lacks a domestic capital goods producing sector and finally, a higher wage share must reduce the rate of technological progress. When these conditions hold, this chapter formally demonstrates that the growth-equality tradeoff is binding for the technological laggard (Kuznets 1955; Scully 1991; Okun 1975; Kaldor 1957; Mirrless 1971). A newly emerging consensus (Stiglitz 2013; Piketty 2014; Berg et al. 2018; Cingano 2014) challenges this conventional notion that there is a growth-equality tradeoff. It has since become fashionable to talk in terms of inclusive growth and progressive taxation is now on the policy agenda in many countries. To demonstrate the power of the newly emerging consensus, *reducing inequality within and between countries*, is now one of the United Nations' sustainable development goals. This chapter thus contributes to the literature on convergence and divergence in regional groupings and EMUs but also the wider literature on economic growth and distribution.

It is well established in the balance of payments constrained growth literature that non-price competitiveness—the ratio of foreign trade elasticities—is a deep determinant of long-run growth (Thirlwall 2011). In a two-country model with a common currency—an EMU—this chapter endogenizes non-price competitiveness for the laggard economy—the home country. It demonstrates that income distribution and public investment in learning and key infrastructure are the driving forces of technological change and non-price competitiveness.

Though income distribution has ambiguous effects on the rate of technological change, the model presents a novel mechanism by which lower inequality can reduce long-term growth. A higher wage share can undermine non-price competitiveness as it lowers the share of imported capital goods in total imports. These are important for technological change in the laggard economy, which lacks a domestic capital goods producing sector. It follows that fiscal redistribution increases the weighted average of income elasticity of import demand and consequently, reduces the long-run growth rate. The precise mechanism relates to a higher wage share, lower rate of technological progress and lower balance of payments constrained growth rate. The growth-equality tradeoff is still binding for laggard economies. However, a virtuous cycle between lower income inequality and convergence is possible but only for the least developed laggard economies. The conditions for such an outcome are stricter. Only when the laggard has unequal access to and poor quality schooling and health care facilities that lower income inequality can enhance learning and technological change. As the laggard exceeds a threshold level of poverty, the tradeoff emerges.

On account of the earlier assumptions and the channels through which distribution matters for technological change, the model is applicable to particularly small open economies or larger open economies with limited capacity to produce its own capital goods. For example, small island states in Europe, the Pacific and Caribbean. In these economies, technological change relies on emulation and adaptation of imported technologies and capital goods. Unlike the literature that show how higher wage shares reduce profits, R&D expenditure and technological change (Missio et al. 2017; Ribeiro et al. 2016; Missio and Jayme 2012; Fiorillo 2001), this chapter identifies how a higher wage share can increase the share of imported consumer goods at the expense of imported capital goods. In these economies, R&D at the firm-level is less important as compared to firm-level reverse engineering, which rely on imported capital goods and the National System of Innovation. It follows that countries with initially high income inequality, conspicuous consumption of imported consumer goods and low quality domestic output, face a sharp tradeoff between distribution and economic growth.

One important contribution of this chapter is that it presents these insights in a dynamically stable model of an economy with a low wage share and a high technological gap. Other works find vicious or virtuous cycles of growth and distribution depending on the unstable comparative dynamics (Ribeiro et al. 2016; Martins Neto 2017). The finding of a growth-equality tradeoff is not new but this chapter does present the new channels of technological divergence and increases in the income elasticity of imports. Other works argue for the tradeoff through an efficiency channel (Garcia-Penalosa and Turnovsky 2007; Muinelo-Gallo and Roca-Sagales 2011; 2013; Okun 1975) or the price competitiveness mechanism, associated with Blecker (1989) and Bhaduri and Marglin (1990). In the case of the latter mechanism, higher wage shares reduce international price competitiveness and economic growth. But in laggard economies that export a handful of commodities or a low quality consumer good in the case of this chapter, domestic income distribution does not influence world prices. In terms of the efficiency channel, higher taxes for redistribution present distortionary effects that reduce economic growth. In this chapter, fiscal redistribution is not undertaken through higher taxes, rather, a reallocation of funds from public investment, so these distortionary effects do not arise.

This chapter is closely related to the literature on the demand determinants of trade flows (Adam et al. 2011; Flam and Helpman 1987; Bekkers et al. 2012; Choi et al. 2009; Dalgin et al. 2008; Mitra and Trindade 2005; Hunter 1991). These scholars show theoretically and empirically that lower inequality reduces the demand for imports. The key argument is that as inequality falls, the demand for imported luxury goods declines and consumption switches to *domestic production.* Much of the empirical literature is confined to developed countries and emerging markets where domestic production is a quality variant of imported goods. The assumption of switching to domestic production—a quality variant of imported goods—makes these insights less applicable to the laggard economies the author has in mind, where domestic production and imported consumer goods are imperfect substitutes. Moreover, the model's assumption that the laggard economy has a more unequal distribution of income, allows for the likelihood of conspicuous consumption. Unlike the literature just cited, conspicuous consumption allows for increases in demand for imported consumer durables as inequality falls (Ray and Vatan 2013).

The chapter also makes the case that the tradeoff is partly imposed by design. In this chapter, the economic policy framework of the EMU imposes stringent limits on debt and deficits without any compensatory mechanisms like a fiscal union or union-wide cohesion or technology policy. Given this straitjacket of an economic policy framework, laggard economies are promised the tale of convergence but experience technological divergence that undermine long-run growth. The central policy implication, whether at the level of an EMU or world economy, is that a union-wide technology policy is required to promote economic convergence. For example, the big tradeoff becomes less binding if the EMU or world organizations provide for investments in technological innovation and emulation that assist laggard economies in the catching-up process.

The remainder of the chapter is organized as follows. Section 3.2 outlines the theoretical model and section 3.3 presents the comparative dynamic results. Finally, section 3.4 concludes.

3.2 Model

Assume that an Economic and Monetary Union (EMU) consists of two countries: a technologically advanced foreign country and a technological laggard, the home country. An independent central bank issues the common currency and there is no fiscal union. Each country is obligated by treaty to maintain balanced fiscal accounts and observe both debt and deficit limits.

Given these rules, neither country competes on its tax rate and even if this assumption is relaxed, it is assumed that the race to the bottom holds; so that neither country can gain a competitive advantage by reducing its rate of taxation. Similarly, if one country attempts to raise public revenue by increasing its tax rate, it does injury to its public purse as capital can move freely to the jurisdiction with a lower tax rate. In short, the rates of taxation are given and assumed to be the same between countries. The key implication of this fiscal framework—the absence of a fiscal union and strong limits on debt and deficits—is that under certain conditions, there are hard tradeoffs to fiscal expenditure at the level of member states.

There are three agents in this model, capitalists who save a fraction of their profits, workers who consume all wage income and government that decides how to allocate its resources among competing demands. This chapter brings into focus two demands:

- Technological convergence
- Reducing inequality.

It is assumed that the technological laggard—the home country—has a more unequal distribution of income as compared to the technological leader. In this chapter, the model focuses on the functional income distribution, i.e. the distribution of wages and profits in national income.

3.2.1 Extended Balance of Payments Constrained Growth Model

The home country is a one-sector economy that produces and exports one sort of consumption good. By implication of the technological gap, the consumption good is of comparatively lower technological-intensity. The foreign country is a two-sector economy that produces and exports industrial consumption and capital goods. As such, the home country's import demand can be divided into the categories of consumption (M^c) and capital goods (M^i). Crucially, M^c and the home country's consumption good are imperfect substitutes and both capitalists and workers consume domestic and foreign goods. Given the assumption of higher income inequality in the home country, it is plausible to assume that the richer class—capitalist class—conspicuously consumes the foreign good, which is of better quality. This implies that the consumption of M^c also signals social status and ergo, increases the working class' latent demand for the foreign consumer good.[1] It is assumed that the home country does not have a domestic capital goods producing sector, therefore, capital accumulation is exclusively dependent on M^i. This is a strong assumption but even in its weaker form, where the technological laggard has a small capital goods sector, M^i remains an important part of capital formation. In this model, the strong assumption is maintained to operationalize the promise of technological convergence, as membership in an EMU reduces the costs of M^i through the removal of tariff and non-tariff trade barriers.

Two homogeneous factors of production are used in the production process, imported capital and labour (L), which are combined through a fixed-coefficient technology to produce the consumer good (Y).

$$Y = \min(aL, bM^i) \tag{3.1}$$

The corresponding productivity coefficients for labour and imported capital are a and b respectively and the fixed-coefficient combination is determined by the existing stock of knowledge. The latter determines the difference in input efficiencies independent of relative factor prices and this implies that the elasticity of substitution between L and M^i is zero. This warrants a short discussion. Indeed, the empirical literature indicates that the elasticity of substitution is greater than zero but less than one.[2] For example, Rowthorn (1999) finds that

[1] Veblen (1994) notes that the rich consume goods and services to display their wealth and social status.

[2] For empirical evidence see Semieniuk (2017a), Leon-Ledesma et al. (2010), Chirinko (2008) and Rowthorn (1999).

the median elasticity of substitution is 0.58 for a selection of advanced countries near the technological frontier. But there are strong theoretical reasons why the elasticity is much closer to zero for technological laggards. First, as noted by Piketty and Zucman (2014), capital has fewer alternative uses in low-technology economies and this lowers the flexibility of capital-labour substitution. Second, the imported capital may not be ideally suited for the production of the domestic good and this reduces the elasticity of substitution. It follows that the appropriateness of imported technology or capital is an important determinant of the substitutability of capital for labour. Third, the low-technology nature of the domestic good may require specific factor proportions in the production process and this also undermines the flexibility of substitution. Accordingly, the fixed-coefficient technology assumption captures the inappropriateness of imported capital and the necessity of labour in given proportions in the production process.

The export demand function is given by Equation (3.2), where Z represents income in the foreign country and P_h and P_f are the level of prices in the home and the foreign country respectively. The parameters $\alpha < 0$ and $\beta > 0$ are the price and income elasticities of export demand respectively.

$$X = \left(\frac{P_h}{P_f}\right)^{\alpha} Z^{\beta} \tag{3.2}$$

In growth rate form:

$$x = \alpha(p_h - p_f) + \beta z \tag{3.3}$$

Import demand assumes two specifications, where it is assumed in the interest of simplicity that $P_f = P_f^i$. This assumption implies that the prices of imported capital and consumer goods are the same over time. The price elasticity of imported consumer and capital goods is $\gamma < 0$ and Y represents the home country's level of income. Equations (3.4a) and (3.4b) show that the income elasticity of demand for consumer and capital imports are $\varepsilon_1 > 0$ and $\varepsilon_2 > 0$ respectively. Moreover, it is assumed that $\varepsilon_1 > \varepsilon_2$. This assumption is uncontroversial since one expects the demand for consumer imports to increase faster than capital imports when aggregate income in the home country increases.

$$M^c = \left(\frac{P_f}{P_h}\right)^{\gamma} Y^{\varepsilon_1} \tag{3.4a}$$

$$M^i = \left(\frac{P_f^i}{P_h}\right)^{\gamma} Y^{\varepsilon_2} \tag{3.4b}$$

In growth rate form:

$$m^c = \gamma(p_f - p_h) + \varepsilon_1 y \tag{3.5a}$$

$$m^i = \varepsilon_2 y \tag{3.5b}$$

The balance of payments identity is given by:

$$P_h X = P_f(M^c + M^i) \tag{3.6}$$

and in rates of change:

$$p_h + x = p_f + \theta m^c + (1-\theta) m^i \tag{3.7}$$

where $\theta = P_f M^c / M$; $(1-\theta) = P_f^i M^i / M$ and the restriction $0 < \theta < 1$ holds. It is important to note here that the import shares are not constant.

Substitution of Equations (3.3), (3.5a) and (3.5b) into (3.7) derives the home country's balance of payments constrained growth (BPCG) rate.

$$y_{BP} = \frac{\beta z + (1+\alpha+\gamma)(p_h - p_f)}{\theta\varepsilon_1 + (1-\theta)\varepsilon_2} \tag{3.8}$$

Equation (3.8) reproduces the standard result with the extension that the income elasticity of import demand is a weighted average of the income elasticities of demand for imported consumer and capital goods. It is noteworthy that changes in the distribution of import shares affect the equilibrium growth rate. For example, an increase in θ—the share of consumer imports in total imports—reduces the balance of payments constrained growth rate.

Assuming that $(p_h - p_f) = 0$ or that relative costs are constant in the long-term, Thirlwall's Law is derived in Equation (3.9). Thirlwall (1979) explains that a country's rate of economic growth consistent with balance of payment equilibrium, is a positive function of the growth of foreign demand and non-price competitive factors—the ratio of β/ε. Note that ε is the weighted average of income elasticities of import demand.

$$y_{BP} = \frac{\beta}{\varepsilon} z \tag{3.9}$$

3.2.2 Endogenizing the Trade Elasticities

This section endogenizes the ratio of foreign trade elasticities or non-price competitiveness as a function of the inverted technological gap and income distribution. Define the inverted technological gap (S) as:

$$S = T_h / T_f \tag{3.10}$$

where T_h and T_f are technological capabilities in the home and foreign country respectively. Let $\beta / \varepsilon = \Psi$ so that:

$$y_{BP} = \frac{\beta z}{\varepsilon} = \Psi z = (k_0 + k_1 S \pm k_2 \sigma_L) z \tag{3.11}$$

The positive formulation between Ψ and S relate to the basic hypothesis that an increase in the home country's technological capabilities—technological convergence to the frontier—enhances its non-price competitiveness as measured by the ratio of trade elasticities.[3] The principal mechanism is that as the home country increases its technological capabilities, it improves the quality of the consumer good it produces.[4] This is in turn increases its income elasticity of export demand and equilibrium growth rate. This formulation is consistent with the literature. The consensus is that technological convergence between laggard and frontier economy drives the foreign trade elasticities (Davila-Fernandez et al. 2018; Porcile and Spinola 2018; Ribeiro et al. 2016; Cimoli and Porcile 2014; Feijo and Lamonica 2013; Da Silva Catela and Porcile 2012; Krugman 1989). For example, in an aggregate BPCG model,[5] Ribeiro et al. (2016) models the technological laggard as a one-sector economy that imports intermediate capital

[3] Numerous studies have empirically verified that technological change increases non-price competitiveness as measured by the trade elasticities (Gouvea and Lima 2010; Romero and McCombie 2016b; 2018; Cimoli et al. 2010; Martins Neto and Porcile 2017).

[4] Fiorillo (2001), McCombie and Thirlwall (1994) and Fagerberg (1988) argue that technological progress improves product quality, while Krugman (1989) makes the case for product differentiation.

[5] Araujo and Lima (2007) derive Thirlwall's Law using a multi-sectoral BPCG model. They show that the aggregate ratio of foreign trade elasticities is simply the weighted average of sectoral elasticities, so that changes in the sectoral composition of the economy can alter the weighted trade elasticities. See Romero and McCombie (2016b), Gouvea and Lima (2013), Gouvea and Lima (2010) and Bagnai (2010) for empirical support of the multi-sectoral Thirlwall's Law. Since this chapter employs an aggregate BPCG model, it abstracts away the effects of sectoral composition on the trade elasticities.

goods and endogenizes its foreign trade elasticities as a positive function of the inverted technological gap. Ribeiro and his co-authors argue that as the laggard economy converges to the technological frontier, it is better able to produce higher quality goods, which are associated with higher income elasticities in export markets. In other formulations, particularly North-South models, the income elasticity of exports is a positive function of economic complexity,[6] in turn determined by the technological gap (Cimoli and Porcile 2014). These scholars posit that specialization patterns are determined by relative technological capabilities and that income elasticities of export vary by technological specialization. They argue that medium- to high-technology commodities are associated with higher income elasticities as compared to say, low-technology goods in the agricultural sector.

Consistent with the literature, a higher wage share (σ_L) has ambiguous effects on the ratio of trade elasticities and by extension, the balance of payments constrained growth rate. However, this chapter presents a new mechanism by which lower functional income inequality can reduce non-price competitiveness. The hypothesis is that import demand can increase independently of the level of income, so that the share of consumer imports to total imports (θ) is a positive function of the wage share. This implies that lower functional income inequality (higher wage share) increases the weighted average of the income elasticity of import demand and correspondingly, reduces the ratio of foreign trade elasticities. This formulation closely follows the earlier works of Thirlwall and Hughes (1979) and Thirlwall and White (1974), which demonstrate that the tightness of the labour market—usually associated with higher wage shares—increases the demand for imports. It follows that the income elasticity of import demand increases when the labour constraint is binding. More recently, Palley (2003) endogenizes the income elasticity of import demand as an inverse function of excess capacity, which produces lower wage shares, so that capacity constraints or higher wage shares reduce the ratio of foreign trade elasticities. Unlike these works, this model concretely specifies the channel that lower functional income inequality increases the share of imported consumer goods and by extension, the weighted average of income elasticities of import demand. Moreover, recall the earlier assumption of conspicuous consumption—this strengthens the hypothesis that a higher wage share reduces the ratio of trade elasticities. To model

[6]See Hidalgo and Hausmann (2009), Hidalgo et al. (2007) and Hausmann et al. (2007) for evidence that economic complexity and diversification increase economic growth. The key mechanism is that at low (high) levels of economic complexity and diversification, an economy's marginal propensity to import is relatively high (low), which produces a comparatively high (low) income elasticity of import demand and undermines (enhances) non-price competitiveness (Garcimartin et al. 2012: pp. 199).

the positive effects of the wage share on non-price competitiveness, the author follows Porcile et al. (2007)'s formulation and posits that a higher wage share improves workers' capacity to learn and imitate foreign technologies, which in turn increases product quality and the ratio of foreign trade elasticities. The precise mechanisms relate to better access to education and health care (Ranis and Stewart 2002) and stronger motivations to work (Shapiro and Stiglitz 1989) and innovate. However, the positive effect of the wage share only holds up to a threshold level, after which a higher wage share undermines non-price competitiveness. This is the insight of Porcile et al. (2007)'s North-South model with a balance of payments constraint, where real wages beyond a threshold level induces a profit squeeze and undermine product quality, thereby, the balance of payments constrained growth rate.[7] In this model, it is assumed that the negative effect of the wage share emerges after some threshold level but unlike Porcile et al. (2007), the negative effect is related to higher income elasticity of import demand rather than a profit squeeze. In sum, the net effect of the wage share depends on two factors: 1. The negative effect associated with θ and 2. The positive effect associated with workers' enhanced capacity to learn and imitate foreign technologies.

The literature identifies other mechanisms by which distribution affects the trade elasticities. An influential channel relates to the profits-technology-income elasticity of exports causal chain. For example, in a multi-sectoral BPCG model, Missio et al. (2017) demonstrate that a currency devaluation reduces the wage share and increases firm-level profits, which provide the necessary self-financing required for innovation and R&D expenditure. In turn, these improve product quality and the weighted average of trade elasticities. But Ribeiro et al. (2016) add an important note of caution to this linear channel. These scholars present a non-linear relationship between technological change and the wage share in an aggregate BPCG model.[8] This modeling approach builds on the work of Lima (2004), who demonstrates that too low or high wage shares reduce the rate of technological change. The key implication is that devaluations only increase technological progress and the trade elasticities if the wage share is initially high.

In recent work, Ribeiro et al. (2016) presents varying channels through which distribu-

[7]Unlike the formulation in this chapter, Porcile et al. (2007) do not endogenize the trade elasticities, rather, technology enters as an argument in the export demand equation. Moreover, import demand is not disaggregated into capital and consumer goods, so that the negative effect of the wage share as outlined in this chapter is omitted.

[8]Note that Skott (2016) cautions the use of the wage share as an exogenous factor, given the known endogeneities between growth and distribution.

tion matters for non-price competitiveness. In their model, higher wage shares can induce a capital substitution and allow for the production of capital-intensive goods (higher income elasticity of exports), while lower wage shares can reduce the income elasticity of exports by incentivizing capitalists to produce labour-intensive commodities. In the case of income elasticity of imports, a higher wage share increases and decreases the demand for luxury imports for workers and capitalists respectively. The net effect determines how changes in income distribution affect the overall demand for luxury imports and by extension, the income elasticity of imports.[9] Notwithstanding the ambiguous effects of changes in the wage share on the trade elasticities, Ribeiro et al. (2016) assume that a rising wage share has positive effects on non-price competitiveness. These scholars place greater premium on the capital substitution effects of an increase in the wage share. But given the assumption of a fixed-coefficient production technology in this chapter, the capital substitution effects of a higher wage share are weaker in the model presented here.

Other strands of the literature make the case that lower income inequality (higher wage share) reduces the demand for luxury imports and by extension, increases the ratio of foreign trade elasticities (Francois and Kaplan 1996). But this result hinges on the assumptions that domestic and imported consumer goods are substitutes and that the working class does not emulate the consumption pattern of the rich. Absent these conditions, as this chapter assumes, lower income inequality can reduce the foreign trade elasticities and non-price competitiveness.[10]

In short, the ratio of foreign trade elasticities are positively related to the inverted technological gap but ambiguously related to the wage share. To ascertain the effects of distributive policy on the equilibrium growth rate, the dynamics and interaction of technological progress and distribution must be anlayzed.

3.2.3 Technological Change

Assume that technological progress is labour-augmenting (Harrod-neutral) and a function of the inverse of the technological gap, the wage share and the ratio of public investment

[9] It is not inevitable that rising demand for luxury imports increases the income elasticity of imports. This requires that the foreign country alters the quality of its product or the structure of its production to meet the new structure of demand.

[10] For empirical evidence that lower inequality contracts import demand, see Dalgin et al. (2008), Latzer and Mayneris (2012) and Fajgelbaum et al. (2011) and the following studies for evidence to the contrary (Thirlwall and Hughes 1979; Thirlwall and White 1974; Martins Neto 2017).

to GDP. In terms of Freeman and Perez (1988)'s taxonomy of technical change, technological progress in the laggard economy is based on incremental innovation. This in turn produces improvements in the production process that enhance the quality of the consumption good produced.[11] Equation (3.12) says that the rate of technological progress—where $\dot{S}$ is the derivative of S with respect to time—is a negative function of the inverted technological gap, ambiguously related to the wage share and directly related to the share of public investment in total GDP. Government collects and spends the share (Φ) of total GDP and its budget is in balance, so that the tax burden corresponds to the share of public spending in aggregate demand. Taxes are paid by capitalists on a lump sum basis and government allocates its spending between transfers to workers and public investment. The tax share used for redistributive and investment purposes are δ and $1-\delta$ respectively and assumed to be exogenous.

$$\dot{S} = \rho_0 + \rho_1(1-\delta)\Phi \pm \rho_2\sigma_L - \rho_3 S \tag{3.12}$$

As the technological gap narrows, there are fewer opportunities for technological imitation and adoption and weaker effects of knowledge spillovers and transfers, therefore, technological change slows down with convergence (S). This is the standard approach to modeling technical change and the technological gap (Cimoli and Porcile 2014). Moreover, Equation (3.12) illustrates that a higher wage share produces both convergence and divergence effects. This ambiguity emerges because of the following factors: 1. The negative effect associated with θ and 2. The positive effect associated with workers' enhanced capacity to learn and imitate foreign technologies. The latter case is straightforward. Higher wage shares can increase the rate of technological progress as it enhances workers' learning abilities and capacity to better utilize imported technologies. However, higher wage shares can also increase the share of consumer imports in total imports and consequently, crowd out the importation of capital goods, which are important for capital accumulation and technical change. This formulation is unlike other approaches where the wage share acts as a proxy indicator of firms' ability to self-finance R&D activities.[12] This chapter proposes that technological change in laggard economies is less reliant on firm-level expenditure on R&D but more dependent on firm-level modification and adaptation of imported technologies.

[11] Freeman and Perez (1988)'s taxonomy of technical change distinguishes among incremental innovation, radical technical change, new technological systems and techno-economic paradigms.

[12] See Missio et al. (2017), Ribeiro et al. (2016), Missio and Jayme (2012) and Fiorillo (2001) for theoretical models that specify a wage share-profits-technology channel.

This linear modeling of technological progress and income distribution is unlike the non-linear approaches associated with the works of Martins Neto (2017), Ribeiro et al. (2016) and Lima (2004). Martins Neto (2017) and Ribeiro et al. (2016) follow Lima (2004), who models the non-linear relationship between income distribution and technological change. Lima employs a post-Keynesian dynamic model where the relative bargaining power of labour produce non-linearity between accumulation and economic growth. In Lima's model, technological change is labour-augmenting and distribution matters for innovation due to its effects on incentives and resource availability. For example, Lima argues that while firms' incentive to innovate is low (high) when wage shares are low (high), investible resources are abundant (limited). It follows that in Lima (2004), too low or high wage shares reduce the rate of technological change. Typical of non-linear models, Lima finds multiple equilibria and stable and unstable dynamics. For example, when wage shares are low and labour's bargaining power is weak, there is a stable equilibrium between the wage share and technical change. However, the equilibrium becomes unstable when labour's bargaining power is relatively strong. Interestingly, for higher wage shares, the steady-state equilibrium is saddle point unstable irrespective of the relative bargaining power between capitalists and workers.

Martins Neto (2017) and Ribeiro et al. (2016) employ this modeling approach in an aggregate balance of payments constrained growth model. They derive a stable steady-state equilibrium when the technological gap is small and the wage share is high but demonstrate that an economy with a large technological gap and low wage share, produces an unstable steady-state equilibrium. Ribeiro and his co-authors are interested in how a currency devaluation affects income distribution and thus, technological progress. They conclude that devaluations produce an ever decreasing of the wage share and technological progress in economies with large technological gaps and low wage shares (unstable equilibrium). Martins Neto (2017) find similarly unstable results when government increases its distributive transfers to workers. In both formulations, stability emerges by accident when the economy manages to find itself on its saddle path.

Such unstable dynamics of ever decreasing wage share and retardation of technological progress do not adequately capture real world macrodynamics in laggard economies. For this reason, this chapter follows the linear approach in the literature and provides for a stable steady-state equilibrium when technological gaps are large and wages shares are low. However, as noted earlier, in this model, income distribution does not affect internal self-financing. Rather, it affects technological progress through its effects on the share of consumer imports and the efficiency of labour.

The final determinant of the rate of technological progress is the role of the government sector—the National System of Innovation (NSI). In this model, NSI refers to the framework within which government forms and implements policies to influence the innovation process (Metcalfe 1995). Government assumes a leading role in coordinating the various actors (universities, firms, private & national research councils, private & national financial institutions etc;) to accelerate the process of technological emulation, innovation and diffusion (Cimoli 2014; Cimoli and della Giusta 2000; Freeman 1995; Nelson and Rosenberg 1993). Cimoli (2014) explains that the NSI sets the constraints and opportunities each firm faces, e.g. the availability of skilled labour, cheap capital and information on new technologies etc. This body of scholarship concludes that the role of government is to create and diffuse general purpose technologies, develop the technological infrastructure in both private and public sectors and expand certain industries that advance technical change (Freeman and Soete 1997).

Mazzucato and Penna (2015) make the case that public investment is particularly complementary to private ingenuity in developing countries.[13] They show that the Brazilian Development Bank provides low-cost finance to key infrastructure projects and basic industries through a combination of direct lending to industry and indirect financing via private financial institutions. During the 1960s-1970s, the Development Bank disproportionately funded the capital goods producing sector and since the 1990s, greater attention is placed on high-technology firms. Public and low-cost financing become necessary because of the nature of innovation and emulation—high-risk and high-uncertainty. These increase the costs of capital at the level of private institutions and in the absence of government policy, innovation and technological convergence can be crowded out (Mazzucato 2013).

In a series of papers, Keith Nurse argues that inadequate public funding for R&D and data infrastructure are the key reasons for little innovation[14] in the creative industry in the Caribbean (Nurse 2000; 2001; 2011). According to Nurse, Caribbean countries have failed to establish the data infrastructure to capture the economic contribution of their creative industry, thereby, undermining firms' ability to claim royalties and the incentive to develop new products within the sector. Martins Neto and Porcile (2017) is one study that directly connects public investment to non-price competitiveness in a BPCG model, where firm-level innova-

[13] See Dohnert et al. (2017) on how inadequate public policy and poor public capital can reduce firm-level innovation in the Caribbean.

[14] See Alleyne et al. (2017) and Nurse (2007) for evidence that Caribbean countries record substantially lower coefficients of innovation as compared to their peers in Latin America.

tion and emulation in laggard economies are based on efficient public utilities and a skilled workforce. In this regard, Perrotti and Sanchez (2011) and Calderon and Serven (2003) provide evidence to show that feeble public investment in infrastructure is a contributory factor to the widening of the productivity gap between Latin American and Asian countries.[15]

In sum, the evolution of technological change depends on spillover effects, the functional income distribution and public investment in key infrastructure, education & training and technology parks etc., which enhance firms' ability to absorb and improve foreign technologies.

3.2.4 Functional Income Distribution

In this section, the author endogenizes the wage share to illuminate its own dynamics and how it interacts with technological progress to influence the BPCG rate. To do so, consider the mark-up pricing equation of a representative firm, where P_h, τ, W and a are the price level in the home country, the mark-up factor, nominal wages and labour productivity respectively.

$$P_h = \tau\left(\frac{W}{a}\right) \tag{3.13}$$

Dividing (3.13) by the domestic price level, the wage share ($\sigma_L = W/a$) is derived as shown below, where the profit share is σ_K.

$$\sigma_L = 1 - \sigma_K \tag{3.14}$$

The wage share is determined through a bargaining process, where workers set a target or expected wage share (σ_L^e). The growth in the wage share is a positive function of the difference between the expected and actual wage share. This is illustrated in Equation (3.15) where $\lambda > 0$ is an adjustment parameter.

$$\dot{\sigma}_L = \lambda(\sigma_L^e - \sigma_L) \tag{3.15}$$

Let σ_L^e be defined as shown in (3.16), where σ_K^e is the expected profit share and inversely related to the bargaining power of workers.

[15] In the case of an EMU, see Makkonen (2013) for evidence that the Eurozone periphery—Portugal, Spain, Italy and Greece—reduced public investment in R&D since 2008.

$$\sigma_L^e = 1 - \sigma_K^e \tag{3.16}$$

The expected profit share takes the following form where all parameters are positive and e and l are the rate of growth of employment and the labour force respectively. Equation (3.17) says that the expected profit share falls with greater government redistribution to workers and faster rates of employment growth. The principal mechanism is that both redistribution and employment growth enhance the bargaining power of workers and consequently, their wage demands.

$$\sigma_K^e = \omega_0 - \omega_1 \delta \Phi - \omega_2 (e - l) \tag{3.17}$$

By definition, employment growth is the difference between output growth (y_{BP}) and productivity growth ($\hat{a}$), given by Equation (3.18). The latter indicates that economic growth increases employment growth and the bargaining of labour, and based on (3.17), lowers the expected profit share. Further, recall that productivity growth is a positive function of technological progress, shown in Equation (3.19).

$$e = y_{BP} - \hat{a} \tag{3.18}$$

$$\hat{a} = \dot{S} = \rho_0 + \rho_1 (1 - \delta)\Phi \pm \rho_2 \sigma_L - \rho_3 S \tag{3.19}$$

After substitution of Equations (3.11) and (3.16)-(3.19) into (3.15), the wage share evolves as shown below.

$$\dot{\sigma}_L = \lambda\{1 - \omega_0 + \omega_1 \delta \Phi + \omega_2 [(k_0 + k_1 S - k_2 \sigma_L) z - \rho_0 - \rho_1 (1 - \delta)\Phi + \rho_2 \sigma_L + \rho_3 S + l] - \sigma_L\} \tag{3.20}$$

Equation (3.20) demonstrates that a higher wage share has negative and positive effects on its rate of change. The negative effect is binding because workers' demand for higher wages are depressed as the wage share increases and this holds irrespective of the net effect of the wage share. Stability requires that the negative effect dominates and henceforth, this assumption is maintained. Equation (3.20) also shows that the rate of change of the wage share increases as the home country approaches the technological frontier. In other words, the smaller the technological gap, the faster the wage share increases. This result is driven by Equation (3.11), where technological convergence increases the trade elasticities, the BPCG rate and therefore, the bargaining power of labour. It is also transparent in Equation (3.20) that a higher share of government transfers (δ) increases labour's bargaining power and the rate of growth of the wage share.

3.3 Equilibrium

3.3.1 Stability Analysis

Equations (3.12) and (3.20) form a two-dimensional system of differential equations reproduced below.

$$\dot{S} = \rho_0 + \rho_1(1-\delta)\Phi - \rho_2\sigma_L - \rho_3 S$$

$$\dot{\sigma}_L = \lambda\{1-\omega_0+\omega_1\delta\Phi+\omega_2[(k_0+k_1S-k_2\sigma_L)z-\rho_0-\rho_1(1-\delta)\Phi+\rho_2\sigma_L+\rho_3S+l]-\sigma_L\}$$

The Jacobian of the system is:

$$J_{k_2,\rho_2<0} = \begin{bmatrix} \frac{d\dot{S}}{dS} & \frac{d\dot{S}}{d\sigma_L} \\ \frac{d\dot{\sigma}_L}{dS} & \frac{d\dot{\sigma}_L}{d\sigma_L} \end{bmatrix} = \begin{bmatrix} -\rho_3 & -\rho_2 \\ \lambda\omega_2 k_1 z + \lambda\omega_2\rho_3 & -\lambda\omega_2 k_2 z - \lambda + \lambda\omega_2\rho_2 \end{bmatrix}$$

when the net effect of the wage share on the trade elasticities and technological progress is negative ($k_2;\rho_2 < 0$). The trace of the Jacobian matrix is $-\rho_3 - \lambda\omega_2 k_2 z - \lambda + \lambda\omega_2\rho_2 < 0$ and hence always negative. Recall that it is assumed that the negative effect of the wage share on its rate of change dominates the positive effect. The determinant of the Jacobian matrix is $\rho_3(\lambda\omega_2 k_2 z - \lambda + \lambda\omega_2\rho_2) - \rho_2(\lambda\omega_2 k_1 z + \lambda\omega_2\rho_3)$. Stability requires that $\rho_3(\lambda\omega_2 k_2 z - \lambda + \lambda\omega_2\rho_2) > \rho_2(\lambda\omega_2 k_1 z + \lambda\omega_2\rho_3)$, otherwise the equilibrium has a saddle path. It is assumed that the determinant is unambiguously positive and therefore, the system has a stable focus (see Figure 3.1a). This implies that cyclical fluctuations around the equilibrium point a is stable and converges back to equilibrium.

When the net effect of the wage share on the trade elasticities and technological progress is positive ($k_2;\rho_2 > 0$), the Jacobian of the system is:

$$J_{k_2,\rho_2>0} = \begin{bmatrix} \frac{d\dot{S}}{dS} & \frac{d\dot{S}}{d\sigma_L} \\ \frac{d\dot{\sigma}_L}{dS} & \frac{d\dot{\sigma}_L}{d\sigma_L} \end{bmatrix} = \begin{bmatrix} -\rho_3 & \rho_2 \\ \lambda\omega_2 k_1 z + \lambda\omega_2\rho_3 & \lambda\omega_2 k_2 z - \lambda - \lambda\omega_2\rho_2 \end{bmatrix}$$

The trace of the Jacobian matrix is $-\rho_3+\lambda\omega_2 k_2 z-\lambda-\lambda\omega_2\rho_2 < 0$ and hence always negative. The determinant of the Jacobian matrix is $\rho_3(\lambda\omega_2 k_2 z-\lambda-\lambda\omega_2\rho_2)-\rho_2(\lambda\omega_2 k_1 z+\lambda\omega_2\rho_3)$. Stability requires that $\rho_3(\lambda\omega_2 k_2 z-\lambda-\lambda\omega_2\rho_2) > \rho_2(\lambda\omega_2 k_1 z+\lambda\omega_2\rho_3)$, otherwise the equilibrium has a saddle path. It is assumed that the determinant is unambiguously positive and therefore, the system has a stable focus (see Figure 3.1b). This implies that cyclical fluctuations around the equilibrium point a' is stable and converges back to equilibrium.

The equilibrium technological gap ($\dot{S} = 0$) is illustrated below where all parameters are positive.

$$S^* = \frac{\rho_0 + \rho_1(1-\delta)\Phi \pm \rho_2\sigma_L}{\rho_3} \tag{3.21}$$

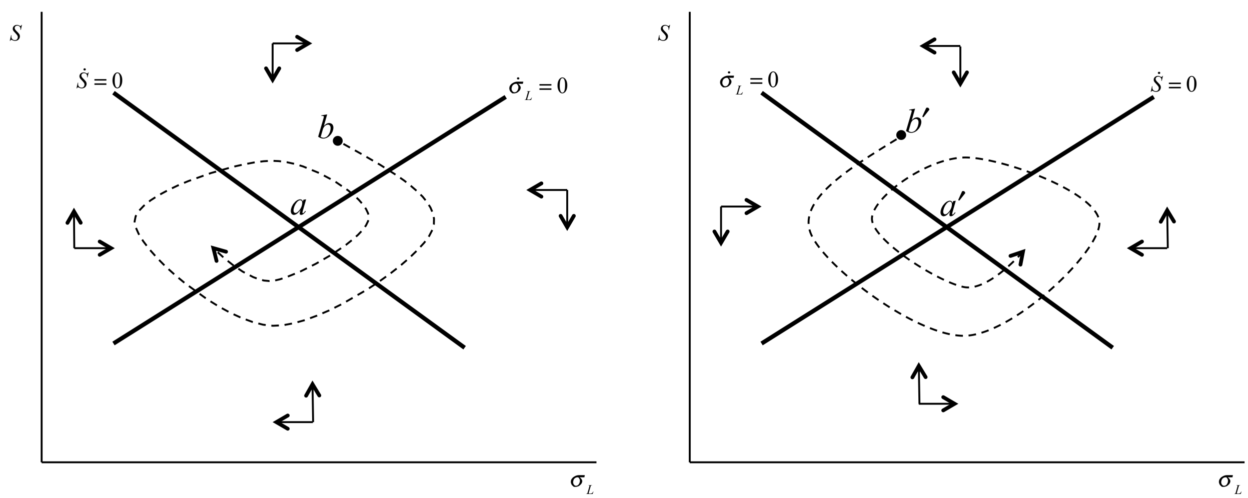
Similarly, when $\dot{\sigma}_L = 0$, the equilibrium wage share is given by (3.22), where $\xi_0 = \omega_0 - 1 + \omega_2[-k_0 z + \rho_0 + \rho_1\Phi - l] >$ or < 0, $\xi_1 = -\omega_1 - \omega_2\rho_1 < 0$, $\xi_2 = 1 + \omega_2 k_2 z - \rho_2 > 0$ and $\xi_3 = \omega_2(k_1 z + \rho_3) > 0$. Here it is assumed that $\xi_0 < 0$ and $\xi_2 > 0$ when the negative effect of the wage share dominates ($k_2;\rho_2 < 0$). Conversely, when the net effect of the wage share is positive ($k_2;\rho_2 > 0$), $\xi_0 > 0$ and $\xi_2 = 1 - \omega_2 k_2 z + \rho_2 < 0$.

$$S^* = \frac{\xi_0 + \xi_1\delta\Phi + \xi_2\sigma_L}{\xi_3} \tag{3.22}$$

It is now possible to derive some implications of the model. First, a smaller technological gap increases the BPCG rate but contracts productivity growth. When the former exceeds the latter, employment growth increases and this strengthens workers' bargaining power. In turn, the rate of growth of the wage share accelerates and the corresponding effects depend on how the wage share affects technological change and the trade elasticities. When the net effect is negative, a higher wage share contracts the rate of technological progress and the balance of payments constrained growth rate. In the case where the net effect of the wage share is positive, a higher wage share activates further rounds of technological progress and economic growth. However, as the wage share rises, wage demands contract, which reduces the wage share along with technological progress and economic growth. It follows that technological convergence does not engender a cumulative growth process—it sows the seeds of its own destruction. These mechanisms demonstrate the inherent stability in the growth process and the stable dynamics between technological change and income distribution. The second point to emphasize is that a higher wage share or lower income inequality is only possible through government redistribution and faster economic growth. The latter does not imply that economic growth is unambiguously inclusive—faster growth is more likely to enhance the bargaining power of workers when labour has the right to collective bargaining and the working class is united. Third, the equilibrium wage share does not indicate a distributional outcome that is considered to be fair or desirable or one where all participants in the bargaining process are happy. It is simply a stable distributional outcome when neither competing classes can improve their income share given the prevailing distribution of power. Fourth, the growth process is ultimately demand-led, the supply-side variables on growth are mediated by their specific effects on the foreign trade elasticities, rather than by price flexibility or the swift reallocation of factors of production. Supply-side effects are related to systems of learning and emulation that improve product quality.

Figure 3.1: Stable Equilibrium

(a) Wage Share: Negative Net Effect ($k_2; \rho_2 < 0$) **(b)** Wage Share: Positive Net Effect ($k_2; \rho_2 > 0$)



Consider a possible case of converging fluctuation that characterizes the system, when the net effect of the wage share on the trade elasticities and technological progress is negative ($k_2; \rho_2 < 0$). Assume that the economy is initially at point b in Figure 3.1a, where both the technological gap and the wage share are above their equilibrium values. This disequilibrium ignites a decline in technological progress, growth in labour productivity and the balance of payments constrained growth rate. As illustrated in Figure 3.1a, the wage share rises so that productivity growth declines faster than the BPCG rate. In other words, the bargaining power of workers increases and so does the rate of change of the wage share. Once the trajectory of the economy crosses the isocline $\dot{\sigma}_L = 0$, the rate of technological change declines even further as strong employment growth continues to increase the wage share. However, further technological retardation accelerates the decline in the BPCG rate relative to productivity growth, until employment growth wanes. It follows that labour's bargaining power decreases and triggers a reduction in the wage share. As the economy crosses the isocline $\dot{S} = 0$, the contraction in the wage share continues and it increases the growth rate of technological progress, which increases productivity growth relative to the BPCG rate and further undermines the wage share. These adjustments continue as the economy crosses the isocline $\dot{\sigma}_L = 0$, where further decreases in the wage share accelerates technological progress. As such, the BPCG rate increases and expands employment growth, along with the wage share. Once the economy crosses the isocline $\dot{S} = 0$, the higher wage share undermines technological progress and these adjustments continue until the cyclical fluctuations in the wage share and technological progress dampen and obtain the stable equilibrium at point a.

Now consider the case of converging fluctuation when the net effect of the wage share on the trade elasticities and technological progress is positve ($k_2; \rho_2 > 0$). Assume that the economy is initially at point b' in Figure 3.1b, where the technological gap and the wage share are above and below their equilibrium values respectively. The disequilibrium wage share triggers a reduction in the rate of technological progress, productivity growth and the balance of payments constrained growth rate. As demonstrated in Figure 3.1b, the wage share contracts, so that the BPCG rate falls faster than productivity growth, which lowers employment growth (labour's bargaining power). Once the economy crosses the isocline $\dot{\sigma}_L = 0$, the rate of technological progress, productivity growth and the balance of payments constrained growth rate continue to fall. These downward adjustments persist as the economy crosses the isocline $\dot{S} = 0$, where further reductions in the rate of technological progress lower productivity growth relative to the BPCG rate. It follows that employment growth and labour's bargaining power recover as the rate of technical change reaches its trough. In turn, wage demand rises and accelerates growth in the wage share and technology. When the economy crosses the isocline $\dot{\sigma}_L = 0$, a positive feedback mechanism emerges between technological change and growth in the wage share. These positive feedbacks are sustained until the wage share reaches its peak and wage demands contract. As the economy crosses the isocline $\dot{S} = 0$, a downward spiral emerges and the adjustments continue until the cyclical fluctuations in the wage share and technological progress dampen and obtain the stable equilibrium at point a'.

3.3.2 Comparative Dynamics

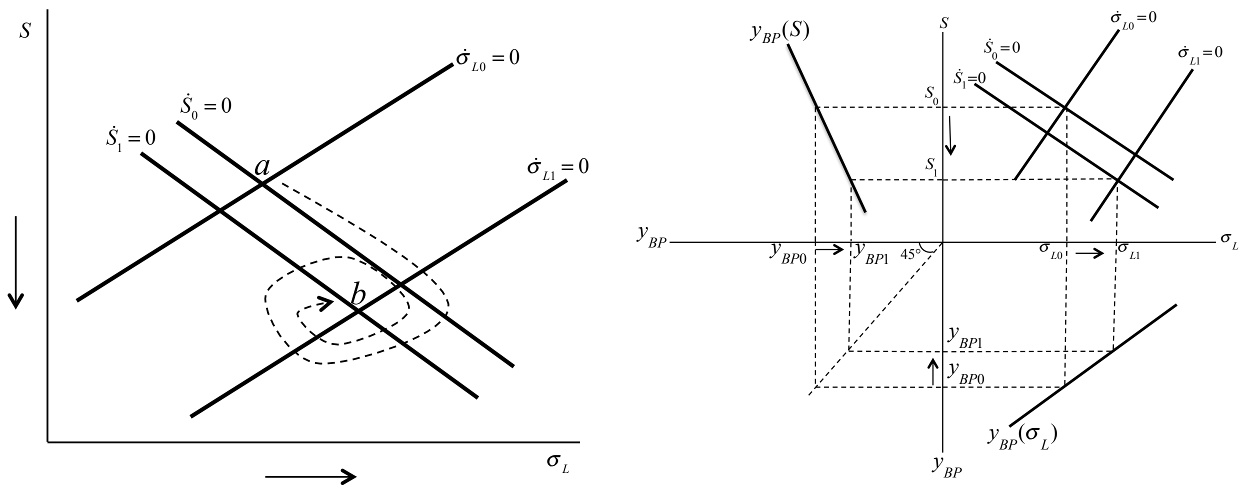
3.3.2.1 Distributive Policy and The Big Tradeoff

The comparative dynamic results presented here relate to a positive shock to the share of tax revenue used for redistribution (δ) and it is assumed that the net effect of the wage share on the trade elasticities and technological progress is negative ($k_2; \rho_2 < 0$). Figure 3.2a illustrates the long-run consequences in terms of the technological gap and the wage share. Initial equilibrium is given by point a. As demonstrated in Equation (3.21), an increase in δ shifts the technology curve or the locus $\dot{S}_0 = 0$ downwards to $\dot{S}_1 = 0$. Simultaneously, the wage share curve or the locus $\dot{\sigma}_{L0} = 0$ shifts to the right and downwards to $\dot{\sigma}_{L1} = 0$. This result is driven by the parameter $\xi_1 < 0$ in Equation (3.22). It is transparent that government redistribution increases the equilibrium wage share in the long-run but also increases the equilibrium technological gap between the home and the foreign country, as demonstrated by the new equilibrium at point b. The mechanisms are as follows. More extensive redistribution increases workers' negotiating power during the wage bargaining process and this inevitably increases their wage share and induces a significant decline in the rate of technological progress. A higher wage share undermines capital accumulation as it reduces the share of imported capital goods. These adjustments continue and reduce the BPCG rate when the locus $\dot{\sigma}_{L1} = 0$ is crossed, where a lower rate of output growth undermines workers' bargaining power and the wage share through weaker employment growth. As the wage share falls, the rate of technological progress and the BPCG rate increase when the locus $\dot{\sigma}_{L1} = 0$ is crossed again. As economic growth expands, the rate of growth of employment accelerates and the wage share recovers, until it reduces the rate of technological progress yet again when the locus $\dot{S}_1 = 0$ is crossed. These cyclical fluctuations dampen over time, until the new equilibrium at point b is reached, with a wider technological gap and a higher wage share.

These comparative dynamic results illustrate a hard tradeoff between technological convergence in the EMU and a more egalitarian distribution of income in the laggard economy. It is important to emphasize that the tradeoff is partly related to the economic policy design of the EMU. For example, the laggard economy is constrained by treaty obligations from borrowing to finance both public investment in the NSI and redistributive transfers. But it must be noted that the laggard economy still faces a tradeoff even if these treaty obligations are relaxed. Ultimately, creditors must ascribe some subjective valuation about the laggard's ability to repay debt and this ability is closely related to its economic performance, which has a

Figure 3.2: Distributive Policy and The Big Tradeoff

(a) A Positive Shock to Redistribution (δ) **(b)** Technological Gap, Distribution and Growth



ceiling by virtue of the low quality commodity it produces. It is possible that society and government may prefer less redistribution and thus, increase the share of tax revenue used for investment purposes. In this case, the reverse results hold—the laggard economy reduces the technological gap but the equilibrium wage share is substantially reduced. In this model, the author assumes that the home country has initially high income equality—low wage shares. Under such an initial condition, it is plausible that demands for redistribution are intense and through populist politics, it is likely that redistribution is undertaken.[16] This prediction becomes stronger when the prospects of joining an EMU increases the expectation of cheaper consumer imports. In short, real politick produces convergence in distribution but divergence in technological capabilities.

Four conditions are required to produce the hard tradeoff: 1. The absence of a fiscal union or transfers, 2. Significant technological gap, 3. Significant differences in income distribution between frontier and laggard economy and 4. Conspicuous consumption in the laggard economy. If condition 1 is relaxed, the tradeoff becomes less binding. For example, the laggard economy can choose to reduce income inequality and utilize regional fiscal transfers for technological upgrading. Alternatively, the laggard can invest its own resources in the process of technological catch-up and increase its claim on the fiscal union for distributive purposes. This insight best illustrates the imperative of regional cohesion policies and the design

[16]See Pineiro et al. (2016) and Leon (2014) for recent evidence in the case of Latin America that initially high income inequality produces intense cycles of populism and redistribution.

framework of economic policy at the regional level more generally.[17] It is obvious that in the absence of condition 2, the tradeoff is non-existent. Condition 3 captures an often ignored convergence criteria within regional groupings. When member states of an EMU experience different distributional outcomes these generate both centripetal and centrifugal forces[18] that relax or tighten the tradeoff.[19] For example, skilled labour may migrate to the frontier, which lowers the rate of technological convergence but can also reduce distributional tensions.[20] However, the evidence shows that skilled migration do not reduce distributional contestation in laggard economies and this reinforces the hard tradeoff.[21] If condition 4 is relaxed, the tradeoff is less intense as lower income inequality does not necessarily crowd out the share of imported capital goods. This insight demonstrates that the tradeoff is also related to social norms and elites' behavior, i.e. status consumption. Finally, when conditions 3 and 4 are combined, the tradeoff becomes entrenched.

Consider Figure 3.2b, which illustrates the growth payoffs when the tradeoff between distribution and technological convergence is binding. Quadrant I shows the wage share and technological gap that are consistent with long-run equilibrium and quadrant II illustrates the positive relationship between the BPCG rate and the inverse of the technological gap. In quadrant IV, the negative relationship between the wage share and the BPCG rate is outlined. An increase in δ is indicative of a rise in the share of redistributive transfers and starting from quadrant I with an initial equilibrium of $S_0 - \sigma_{L0}$, a rise in δ shifts the $\dot{\sigma}_{L0} = 0$ curve to $\dot{\sigma}_{L1} = 0$ and simultaneously presents a downward shift in the technology curve from $\dot{S}_0 = 0$ to $\dot{S}_1 = 0$. As demonstrated earlier, this increases the wage share from σ_{L0} to σ_{L1} but at the cost of a wider technological gap, S_0 decreases to S_1. The increase in the wage share contracts long-run growth from y_{BP0} to y_{BP1} in quadrant IV, as it increases the weighted average of income elasticities of import demand. Further, as shown in quadrant II, a widening of the technological gap

[17] See Stockhammer et al. (2015) for a comprehensive discussion of how the badly designed policy framework in the Eurozone created and promoted forces of divergence.

[18] Centripetal and centrifugal forces are those that reduce and increase income inequality respectively.

[19] According to Samuelson (1948) and Samuelson (1949) free trade leads to factor price equalization and reduces concerns over distribution. This theory assumes that firms do not have market power and that neither capital nor labor are mobile. However, capital mobility and firms' market power weaken this prediction. The evidence against factor price equalization is overwhelming: see Stockhammer (2017) and Doan and Wan (2017) for evidence of falling wage shares in both developed and developing countries. The exception is of course China but if this outlier is excluded, global inequality is rising (Milanovic 2016; Alvaredo et al. 2018).

[20] See Constantine (2018; 2017a) for a discussion on how differences in income inequality among countries affect labour movement within the Caribbean Single Market and Economy and see (Milanovic 2016: pp. 143-137) for a similar discussion at the level of the world economy.

[21] See footnote 15 for evidence.

reduces the BPCG rate from y_{BP0} to y_{BP1}, as the lower technological capabilities in the home country reduce the ratio of its foreign trade elasticities. In sum, redistribution unambiguously contracts long-run economic growth. Do note that the results are reversed if government allocates a greater share of its tax revenue to public investment. In this case, the technological gap narrows and the equilibrium wage share falls, which increases the equilibrium growth rate.

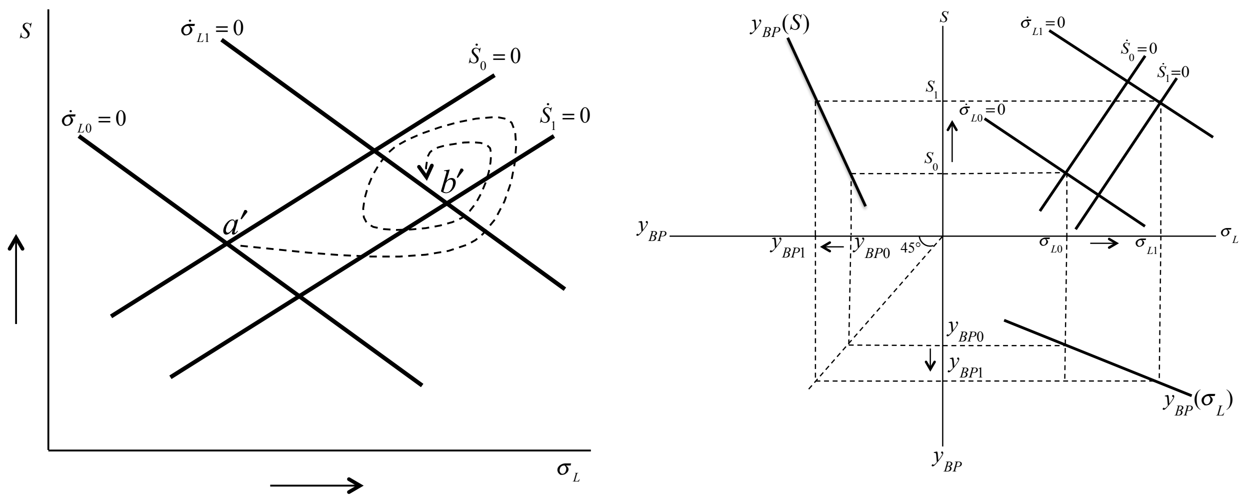
3.3.2.2 Distributive Policy and Technological Convergence

This section presents the comparative dynamic results for a positive shock to δ, when the net effect of the wage share on the trade elasticities and technological progress is positive ($k_2; \rho_2 > 0$). Figure 3.3a illustrates the long-run consequences in terms of the technological gap and the wage share. Initial equilibrium is given by point a'. As illustrated in Equation (3.21), when $\rho_2 > 0$, the locus $\dot{S}_0 = 0$ is upward sloping. Moreover, per Equation (3.22), when ($k_2; \rho_2 > 0$), $\xi_0 > 0$ and $\xi_2 < 0$, so that the wage share curve or the locus $\dot{\sigma}_{L0} = 0$ is downward sloping. A positive shock to δ shifts the technology curve downwards to $\dot{S}_1 = 0$ and simultaneously shifts the wage share curve upwards to $\dot{\sigma}_{L1} = 0$. It is obvious that government redistribution promotes technological convergence and increases the equilibrium wage share, as demonstrated by the new equilibrium at point b'. The mechanisms are as follows. More extensive redistribution increases workers' negotiating power during the wage bargaining process and this inevitably increases their wage share and the rate of technological progress. A higher wage share enhances workers' capacity to learn and imitate imported technology. As the trajectory of the economy crosses the locus $\dot{\sigma}_{L1} = 0$, faster growth in the wage share and technological progress reinforce each other and accelerate the balance of payments constrained growth rate. Collectively, these activate further rounds of growth in the wage share and as the locus $\dot{S}_1 = 0$ is crossed, the wage share reaches its peak. Inevitably, this lowers wage demands and triggers a downward spiral between the rate of technological progress and the wage share. These cyclical fluctuations dampen over time, until the new equilibrium at point b' is reached, with a smaller technological gap and a higher wage share.

Now consider Figure 3.3b, which illustrates the growth payoffs when no tradeoff exists between distribution and technological convergence. Quadrant I shows the wage share and technological gap that are consistent with long-run equilibrium and quadrant II illustrates the positive relationship between the BPCG rate and the inverse of the technological gap. In quadrant IV, the positive relationship between the wage share and the BPCG rate is outlined.

Figure 3.3: Distributive Policy and Technological Convergence

(a) A Positive Shock to Redistribution (δ) **(b)** Technological Gap, Distribution and Growth



An increase in δ is indicative of a rise in the share of redistributive transfers and starting from quadrant I with an initial equilibrium of S_0—σ_{L0}, a rise in δ shifts the $\dot{\sigma}_{L0} = 0$ curve upward and to the right to $\dot{\sigma}_{L1} = 0$ and simultaneously presents a downward shift in the technology curve from $\dot{S}_0 = 0$ to $\dot{S}_1 = 0$. As demonstrated earlier, this increases the wage share from σ_{L0} to σ_{L1} and reduces the technological gap, S_0 increases to S_1. The expansion in the wage share accelerates long-run growth from y_{BP0} to y_{BP1} in quadrant IV, as it increases workers' ability to learn and reverse engineer imported technologies. Further, as shown in quadrant II, a smaller technological gap increases the BPCG rate from y_{BP0} to y_{BP1}, as higher technological capabilities in the home country increase the ratio of its foreign trade elasticities. In sum, redistribution unambiguously accelerates long-run economic growth. Do note that the results are reversed if government allocates a greater share of its tax revenue to public investment. In this case, the equilibrium technological gap and wage share expands and contracts respectively, which reduce the balance of payments constrained growth rate.

Under what conditions do public investment undermine long-term growth and technological convergence? Alternatively, under what conditions do lower income inequality produce technological convergence and economic growth? Higher wage shares become consequential to learning when the NSI is particularly weak, i.e. there are poor quality public schooling and/or unequal access to education. It follows that lower inequality can enhance non-price competitiveness, growth and convergence when the NSI is non-existent or weak.

Moreover, when the effects of conspicuous consumption are weak and/or basic human needs are incompletely satisfied, higher wage shares do not retard technological progress by way of lowering the share of imported capital goods. Rather, higher wages are spent on goods at the lowest level of the commodity hierarchy—basic and low quality consumer goods that are domestically produced. When these conditions hold, it is transparent that a higher share of tax revenue dedicated to public investment can produce the counter-intuitive result of lower growth and technological divergence. A higher share of public investment has limited effectiveness when workers have unequal access to key pubic goods and such low wages that they are unable to satisfy basic human needs. The central implication is that redistribution only increases the prospects of growth and convergence in the least developed laggard economies.[22] It follows that the big tradeoff emerges when the laggard economy exceeds a certain threshold of poverty, where workers' consumption pattern emulates the rich.

To sum up, the model and its corresponding comparative dynamic results make the following contributions to the literature. First, it presents a new mechanism by which higher wage shares can lower the rate of technological convergence and the balance of payments constrained growth rate. When capitalists import higher quality consumer goods to display prestige and social status, higher wage shares increase the share of imported consumer goods and the income elasticity of imports. As the share of imported capital goods falls, so does the rate of technological progress and collectively, these tighten the balance of payments constraint. This in turn lowers the rate of long-term growth and widens the technological gap. In this case, a hard tradeoff emerges between distribution on the one hand and faster long-term growth and technological convergence on the other hand. Other works argue for the tradeoff through an efficiency channel (Garcia-Penalosa and Turnovsky 2007; Muinelo-Gallo and Roca-Sagales 2011; 2013; Okun 1975) or the price competitiveness mechanism, associated with Blecker (1989) and Bhaduri and Marglin (1990). Moreover, the chapter contends that the economic policy framework in EMUs must compensate for these tradeoffs, lest regional cohesion is threatened. A fiscal union with transfers to laggard economies can serve an important compensatory role. Second, the model shows that a virtuous cycle is possible between lower income inequality and technological catch-up and growth. However, these results only hold in the least developed laggard economies, where a higher wage share pro-

[22] This does not imply that higher wages or lower income inequality does not increase efficiency and productivity in richer economies. In fact, recent evidence show that the growth-inequality tradeoff is less binding in more developed economies (Berg et al. 2018; Stiglitz 2013). However, these positive effects are likely to have a threshold limit in laggard economies.

motes learning and enhances workers' ability to imitate foreign technology. In the least developed laggard economies, the quality of public schooling is low and the satisfaction of basic consumer needs are incomplete, so that lower income inequality increases access to learning and demand for low quality domestically produced consumer goods. These mechanisms differ from the wage-led growth literature that emphasizes the demand effects only (Bhaduri and Marglin 1990). Further, this contribution qualifies Porcile et al. (2007)'s finding that higher wages promote learning, convergence and economic growth in developing economies. This conclusion is unlikely to hold when the laggard economy has an insignificant capital goods producing sector, a limited range of domestic consumer goods and conspicuous consumers. The model reveals that Porcile et al. (2007)'s finding only holds in the least developed laggard economies. Furthermore, as the latter exceed a threshold level of poverty, a tradeoff between growth and distribution emerges. Third, this chapter presents these insights in a dynamically stable model of an economy with a low wage share and a high technological gap. Other works find vicious or virtuous cycles of growth and distribution depending on the unstable comparative dynamics (Ribeiro et al. 2016; Martins Neto 2017).

3.4 Conclusion

This chapter presents a long-run balance of payments constrained growth (BPCG) model to demonstrate the relationship among endogenous technological change, income distribution and long-run economic growth between countries in an Economic and Monetary Union (EMU). In this model, non-price competitiveness is endogenously determined by technological change and income distribution (wage share). Faster technological change through an improvement in the home country's National System of Innovation, by way of public investment, improves product quality and the income elasticity of its exports, while a more egalitarian distribution of income has ambiguous effects. On one hand, a higher wage share increases import demand for consumer goods and crowds out the share of capital imports. These in turn are necessary for capital accumulation and technology transfer, so that a higher wage share reduces technological change and thus, non-price competitiveness. On the other hand, lower inequality can improve workers' access to education and health care, which enhance their ability to emulate imported technologies, thereby, promoting technological change. When the negative effect of the wage share dominates, the laggard economy confronts a big tradeoff between lowering income inequality and technological convergence. In the plausible scenario where the home country responds to redistributive demands, the technological gap between the laggard and frontier economy expands. In turn, this reduces the home country's balance of payments constrained growth rate and engenders a long-run divergence in per capita incomes. The reverse results hold when higher wage shares accelerate technical change.

The tradeoff is partly determined by the technological backwardness of the home country. In this model, the laggard economy lacks a domestic capital goods producing sector and produces and exports a low quality consumer good. Accordingly, the home country is reliant on the importation of both capital and consumer goods for growth and development. Herein lies the big tradeoff. As fiscal redistribution improves income distribution in the laggard economy, imported consumer goods increase disproportionately and undermine the process of accumulation and technology transfer. The tradeoff is also binding because of the absence of a fiscal union or cohesion/technology policy at the level of the EMU. Technology policy at the EMU level that promotes technological upgrading in the laggard economy can significantly reduce the burden of the tradeoff between government transfers and public investment in the National System of Innovation. It follows that technological and distributional divergence within the EMU are partly by design—bad design of its policy framework. The model also illustrates that lowering income inequality can accelerate technological convergence. But this result only holds in the least developed laggard economies. In the latter, there are unequal access to and poor quality schooling and health care. Further, basic consumption needs are incompletely satisfied, thus, higher wage shares increase the demand for the low quality but domestically produced consumer good. When these conditions hold, lower inequality can increase the rate of technological progress and undermine the tradeoff. However, the tradeoff emerges when the least developed laggard economy exceeds a threshold level of poverty, where workers' consumption pattern emulates the rich.

These results produce a number of complications for policy regarding distribution and growth. First, a laggard economy with a small domestic capital goods producing sector is caught in a trap that produces extractive growth processes—faster growth with high income inequality. Second, such a growth regime is consistent with rising demands for fiscal redistribution that end in balance of payments crises and lower long-run growth. Third, these harsh socio-economic outcomes can be arrested in an EMU if the regional policy framework reduces the burden of technological or distributional convergence. For example, a laggard economy can choose to investment disproportionately in redistribution or technology if it can increase its claim on the fiscal union to ameliorate the tradeoff. This is an important ingredient for regional cohesion and a key policy insight for regional integration processes. Fourth, unlike the standard convergence criteria associated with economic integration, the model shows that initial differences in distributional outcomes matter. In the first instance, these differences anchor the rate of technological convergence (divergence). Furthermore, they determine the intensity of the distributional conflict and by extension, the speed at which the tradeoff emerges. These insights do not present a simply policy solution. Rather, they reinforce economics as the dismal science. However, they do demonstrate the utility of well designed EMUs that place greater emphasis on community cohesion in terms of technological capabilities and distributional outcomes.

The chapter produces several testable hypotheses. First, only the least developed economies can experience inclusive economic growth and second, beyond a threshold level, a tradeoff emerges. Third, the intensity of the tradeoff is higher for economies with initially higher income inequality. Fourth, EMUs without a fiscal union or adequate cohesion/technology policies, will experience technological polarization and its accompanying crises. It is left for future work to empirically verify these propositions.

Chapter 4

To Devalue or Not to Devalue? New Channels and Mechanisms

4.1 Introduction

The debate over the growth and distributional effects of a currency devaluation is an old one but has received renewed attention with recent calls for GREXIT and China's alleged currency manipulation. Moreover, the Eurozone crisis has brought the notion of monetary sovereignty into sharper focus. Several scholars have argued that Greece and Germany's trade deficits and surpluses respectively, could be easily arrested in the absence of the Euro (Stiglitz 2017; Flassbeck and Lapavitsas 2013). These claims rest on substitution effects and changes in relative prices. For instance, Bilson (1978) posits that a devaluation increases the costs of imports relative to domestically produced goods and through substitution effects, employment and income increases. Moreover, net export demand expands due to relative price changes, the assumption is that the Marshall-Lerner condition holds, i.e. that the sum of the price elasticities of exports and imports exceeds unity.

These optimistic predictions of a currency devaluation have been challenged on several grounds. Diaz-Alejandro (1963) and Krugman and Taylor (1978) demonstrate that devaluations increase the profit share and produce contractionary effects owing to capitalists' higher saving propensities. In the case of Krugman and Taylor, additional contractionary effects relate to higher government savings due to taxes on tradables. Ribeiro et al. (2017a), Krugman and Taylor (1978) and Buffie (1986) show that devaluations are uncompetitive (contractionary) if firms' have a high share of imported intermediate inputs in total variable costs. In other words, devaluations increase the cost of production and contract investment demand. In other strands of the literature, devaluations that lower the wage share engender contractionary and expansionary effects in wage-led and profit-led demand regimes[1] respectively (Ribeiro et al. 2017a; Blecker 2011). The differential results hinge on the net effect of a fall in consumption and an increase in investment demand. Since the Asian financial crisis in 1997-98, several scholars underline the contractionary effects devaluations can impose if firms or governments have undertaken foreign currency denominated debt (Kohler 2019; Gatti et al. 2007; Krugman 1999). The principal channels relate to higher risk premium, bankruptcies and higher interest payments. Gylfason and Risager (1984)'s work predates these models and endogenizes fiscal spending as a negative function of external liabilities, so that a devaluation produces austerity effects. Moreover, models within the monetarist framework contend that devaluations reduce real cash balances, increase the rate of interest and contract real output (Islam 1984; Gylfason and Schmid 1983; Guitian 1976). Finally, recent empirical work by Worrell et al. (2018) show that the contractionary effects of devaluations are more likely for economies with highly concentrated export baskets and population sizes of 1.2 million or less.

This chapter contributes to this rich literature by way of a three-period post-Kaleckian model with three income sources (wages, profits and banker rents). In the short-run, a real devaluation produces contractionary effects along the traditional channels of higher external debt payments and real cost of imported capital goods. In the medium-run, the model finds that a devaluation raises the loan rate and reduces the profit share—inducing contractionary effects. The latter result is in contrast to the larger literature on two-class models that formally demonstrate how a devaluation increases the profit share (Ribeiro et al. 2017a; Missio et al. 2017; Ribeiro et al. 2016; Blecker 2011; Fiorillo 2001; Blecker 1989; Krugman and Taylor 1978; Diaz-Alejandro 1963; Alexander 1952). These works employ the mark-up pricing approach to distribution, where firms' mark-up is modeled as a positive function of the real exchange rate, so that a real devaluation increases firms' market power. According to Blecker (1989) and Blecker (2011), a devaluation increases the relative costs of competing goods in international markets and this enables firms to increase their target mark-up or profit share. However, in this model of a small open economy, firms are price takers in world markets, so that a devaluation offers little price competitiveness.

Unlike the channels of risk premium and real balance effects that raise the loan rate, this chapter presents new mechanisms. First, a devaluation increases bankers' liquidity preference for excess reserves in anticipation of rising non-performing loans and as a means to

[1] Note that Skott (2016) cautions the use of the wage-led and profit-led dichotomy, given the known endogeneities between growth and distribution.

prevent flexible devaluations. Second, a devaluation contracts the supply of excess reserves through the sale of central bank securities and the two mechanisms raise the loan rate. Since bankers profit from credit creation, an increase in the loan rate increases bankers' rent share and lowers the profit share. Moreover, bankers' income also increase on account of a higher bond rate and larger holdings of central bank securities. In this model, oligopolistic bankers have price setting powers in both the loan and bond markets, so that further purchases of central bank bonds—to prevent flexible devaluations or capital flight—can only be induced through higher bond rates. Further, a devaluation increases (decreases) banker rent (profit) share through higher profitability of foreign assets in local currency. These medium-run responses engender contractionary effects for the rates of capacity utilization and capital accumulation through the cost and distribution channels. A lower profit share and higher loan rate contract investment demand and higher rent share lowers overall consumption due to bankers' higher savings rate. One exception to the literature on devaluation and a higher profit share is Ribeiro et al. (2017a). They show in a general Keynesian-Kaleckian two-class model that a real devaluation reduces the profit share if the share of imported intermediate inputs in total variable cost is high. They argue that firms must lower their mark-up factor to maintain price competitiveness as a devaluation increases the costs of imported capital. However, this chapter illustrates that the condition of a high share of imported capital is not necessary for a devaluation to lower the profit share. This contribution is closely related to Constantine and Khemraj (2018) but provides several extensions relating to model dynamics and monetary equilibrium in a regime of excess reserves. Constantine and Khemraj present a short-run post-Kaleckian/Keynesian model of bankers, workers and capitalists. In this set-up, bankers can induce a currency depreciation and increase rent income through foreign exchange trading.

Several theoretical models have employed the so-called technology-profits channel, which endogenizes the rate of technological progress as a positive function of firms' retained earnings (Missio et al. 2017; Ribeiro et al. 2016; Feijo and Lamonica 2013; Missio and Jayme 2012; Araujo and Lima 2007). In these works, devaluation raises the profit share and the rate of innovation. This chapter also allows for endogenous innovation as a function of retained earnings (profit share) but also bank finance (loan rate). Thus, a devaluation lowers the rate of technical change, which provides for additional contractionary effects on the long-run rates of capacity utilization and accumulation. Given the contractionary effects in each period, the expansionary effects on the rate of net exports also increases in each period. It is important to emphasize that such improvements in the external balance is at the price of domestic demand stagnation and a lower rate of technological progress.

A noteworthy feature of the model is its approach to the monetary economy: bankers are assumed to have market power in both the loan and bond markets and liquidity preference for excess reserves that become perfect substitutes for loans and central bank bonds at non-zero rates of interest. This monetary set-up is consistent with several developing economies and emerging markets with an oligopolistic banking sector (Khemraj 2014). As it relates to policy, the model argues that prospective devaluers must consider the degree of competition in their banking sector, size of bankers' foreign assets- and loan-capital ratios and whether or not their economy is in a regime of excess reserves. In the latter case, monetary authorities routinely sell central bank bonds to commercial banks to displace their demand for foreign assets as a means to maintain an orderly foreign exchange market (Downes and Khemraj 2019). This has the obvious distributional effect of raising banker rent share and the corresponding contractionary effects.

The remainder of the chapter is organized as follows. Section 4.2 outlines the basic theoretical model and section 4.2.1 presents the short-run results. The comparative dynamic results are discussed in section 4.2.4 and section 4.2.6. Finally, section 4.3 concludes.

4.2 Model

Consider the home country as a small open economy—the technological laggard—that trades a lower quality good with the technological leader—the foreign country. Assume that the home country is a price taker in world markets and that there are imperfect capital flows between countries. Moreover, the home country produces one composite good, which can be consumed, invested or exported. There are three sources of income in the laggard economy: wages earned by workers, profits from enterprise and economic rent from bankers. All three income recipients consume domestic and foreign goods, which are imperfect substitutes. Further, the home country has a fixed exchange rate (e), where an increase in e indicates a devaluation. Three homogeneous factors of production are used—labour, domestic and imported capital goods—and are combined through a fixed-coefficient technology to produce the composite good (Y), see Equation (4.1). Total capital stock K is the sum of domestic (M^h) and imported capital goods (M^f).

$$Y = \min(aL, bM^h, cM^f) \tag{4.1}$$

The corresponding productivity coefficients for labour, domestic and imported capital are a, b and c respectively and the fixed-coefficient combination is determined by the existing stock of knowledge. The latter determines the difference in input efficiencies independent of relative factor prices and this implies that the elasticity of substitution among L, M^h and M^f is zero. This warrants a short discussion. First, as noted by Piketty and Zucman (2014), capital has fewer alternative uses in low-technology economies and this lowers the flexibility of capital-labour substitution. Second, the imported capital may not be ideally suited for the production of the domestic good and this reduces the elasticity of substitution. It follows that the appropriateness of imported technology or capital is an important determinant of the substitutability of capital for labour. Third, the low-technology nature of the domestic good may require specific factor proportions in the production process and this also undermines the flexibility of substitution. Fourth, the home country's domestic capital goods sector may be too small to allow flexible substitution between M^h and M^f. Accordingly, the fixed-coefficient technology assumption captures the inappropriateness of imported capital, the necessity of labour in given proportions in the production process and the limited production of domestic capital goods.

The condition for goods market equilibrium in the absence of government is illustrated below, where S, I and NX are saving, investment and net exports respectively.

$$S = I + NX \tag{4.2}$$

In this model, the investment function is expressed in terms of the stock of capital and assumes the standard neo-Kaleckian form with several extensions (Bhaduri and Marglin 1990; Blecker 2002).

$$g \equiv \frac{I}{p_h K} = I_0 + \phi_1 \pi + \phi_2 u - \phi_3 r_h \Lambda^{DD} - \phi_4 e r_f \Lambda^{ED} - \phi_5 \frac{e p_f}{p_h} \Lambda^{Mf} + \phi_6 \tau \tag{4.3}$$

Animal spirits or investor confidence is captured by I_0 and the profit share and rate of capacity utilization are π and u respectively. It is well established that better investor confidence increases investment demand and that a higher profit share enlarges firms' internal funds for investment expenditure. Further, as u accelerates, firms are encouraged to invest in larger production capacity. Following Hein (2007) and Lavoie (1995), the cost of domestic bank finance ($r_h \Lambda^{DD}$) is included to capture the cost channel but also the redistributive effects among wages, profits and rents. The domestic debt-capital ratio is defined by $\frac{DD}{p_h K} \equiv \Lambda^{DD}$ and r_h is the loan rate in the home country. Due to open capital accounts, firms may choose to incur foreign currency denominated debt, so that the foreign interest rate (r_f), e and external debt-capital ratio ($\frac{ED}{p_h K} \equiv \Lambda^{ED}$) become important determinants of investment demand. The cost of external debt captures balance sheet effects associated with currency mismatches, where a devaluation increases the costs of foreign interest payments in local currency, induces bankruptcies, reduces firms' net-worth and access to foreign finance, thus, contracting investment demand (Kohler 2019; 2017; Cespedes et al. 2004; Krugman 1999). Moreover, the cost of imported capital goods ($\frac{ep_f}{p_h}\Lambda^{Mf}$) also constrain investment demand through the traditional cost channel, where $\frac{M^f}{p_h K} \equiv \Lambda^{Mf}$ is the share of imported capital in total capital stock and $\frac{p_f}{p_h}$ captures relative price levels. Finally, following Lima (2000) and Lima (2004), the rate of technological progess (τ) is included to account for its effects on investment demand. According to Kalecki (1971) and Schumpeter (1912), technological progress opens up new investment opportunities and encourages firms to install the most updated technology or machinery, thus increasing investment demand. The rationale relates to the acquisition of competitive advantage, since firms with the most updated technology can increase productivity and gain market share (Landesmann and Goodwin 1994).

This chapter assumes a classical savings hypothesis, in other words, workers as a class do not save. The savings rate (σ) is thus defined, where bankers' and capitalists' saving rate are (s_b) and (s_c) respectively. Moreover, it is assumed that $s_b > s_c$.

$$\sigma \equiv \frac{S}{p_h K} = (s_c + s_b)u \tag{4.4}$$

Equation (4.5) demonstrates that the ratio of net exports to capital stock is a positive function of the foreign rate of capacity utilization (u_f) and relative prices ($\frac{ep_f}{p_h}$) but negatively related to the domestic rate of capacity utilization. All parameters are positive with the exception of $\nu_3 \lesseqgtr 0$, which is ambiguous depending on whether or not the Marshall-Lerner (ML) condition holds. If the latter holds, the sum of the price elasticities of exports and imports exceeds unity, which indicates that a real devaluation improves the trade balance. For simplicity, it is assumed that the price p_f is the same for imported capital and consumer goods.

$$b \equiv \frac{NX}{p_h K} = X_0 - M_0 + \nu_1 u_f - \nu_2 u + \nu_3 \frac{e p_f}{p_h} \tag{4.5}$$

4.2.1 Short-Run Equilibrium

The short-run equilibrium is defined by the goods market condition $\sigma = b + g$ and the assumptions that the domestic price level and income distribution are constant. It follows that a nominal devaluation ($\uparrow e$) engenders a real devaluation in the short-run.[2] Moreover, a key feature of the short-run equilibrium is excess capacity, so that quantity adjustments dominate. After substitution of Equations (4.3)-(4.5) into the goods market equilibrium condition, the short-run rate of capacity utilization (u^*) yields the following, where $\Psi = I_0 + X_0 - M_0$.

$$u^* = \frac{\Psi + \phi_1 \pi - \phi_3 r_h \Lambda^{DD} - \phi_4 e r_F \Lambda^{ED} - \phi_5 \frac{e p_f}{p_h} \Lambda^{Mf} + \phi_6 \tau + \nu_1 u_f + \nu_3 \frac{e p_f}{p_h}}{s_c + s_b + \nu_2 - \phi_2} \tag{4.6}$$

Given the comparative static result below, where the denominator is assumed to be positive per the Keynesian stability condition, it is clear that a currency devaluation has ambiguous effects on the short-run rate of capacity utilization.

$$\frac{\partial u^*}{\partial e} = \frac{-\phi_4 r_f \Lambda^{ED} - \phi_5 \frac{p_f}{p_h} \Lambda^{Mf} + \nu_3 \frac{p_f}{p_h}}{s_c + s_b + \nu_2 - \phi_2} \lesseqgtr 0 \tag{4.7}$$

The short-run contractionary effects relate to higher interest payments on external debt and the higher cost of imported capital goods measured in local currency, which depress investment demand. The ambiguity emerges due to whether or not the ML condition holds, recall that $\nu_3 \lessgtr 0$. If the ML condition does not hold ($\nu_3 < 0$), so that a devaluation reduces the rate of net exports, it unambiguously reduces the short-run rate of capacity utilization. However, if the ML condition does hold ($\nu_3 > 0$) and improves the trade balance, a devaluation can expand u^* if the increase in the trade balance overcompensates for the contractionary effects associated with higher interest payments on foreign debt and the increased cost of imported capital. Thus, much depends on the existing stock of external debt (Λ^{ED}), the importance of imported capital to the production process (Λ^{Mf}) and the foreign interest rate. The higher are Λ^{ED}, Λ^{Mf} and r_f and the larger the sensitivity of u^* with respect to these factors, the stronger are the overall contractionary effects of a currency devaluation, even if the ML condition holds.

[2] See Razmi et al. (2012) for evidence that a nominal devaluation quickly translates into a real devaluation.

Substitution of Equation (4.6) into (4.3) and (4.5) derives the short-run equilibrium rates of capital accumulation (g^*) and net exports (b^*).

$$g^* = \frac{(s_c + s_b + \nu_2)[I_0 + \phi_1 \pi - \phi_3 r_h \Lambda^{DD} - \phi_4 e r_f \Lambda^{ED} - \phi_5 \frac{e p_f}{p_h} \Lambda^{Mf} + \phi_6 \tau]}{s_c + s_b + \nu_2 - \phi_2} + \frac{\phi_2 (X_0 - M_0 + \nu_1 u_f + \nu_3 \frac{e p_f}{p_h})}{s_c + s_b + \nu_2 - \phi_2} \quad (4.8)$$

The comparative static result of a devaluation on g^* is ambiguous, as shown in condition (4.9). It is transparent that a larger weight is placed on investment demand than on net exports and consumption, as it relates to how these affect the short-run rate of accumulation. It follows that the negative balance balance sheet effect ($-\phi_4 r_f \Lambda^{ED}$) and the higher cost of imported capital goods ($-\phi_5 \frac{e p_f}{p_h} \Lambda^{Mf}$) have stronger contractionary effects on the rate of capital accumulation.

$$\frac{\partial g^*}{\partial e} = \frac{(-\phi_4 r_f \Lambda^{ED} - \phi_5 \frac{p_f}{p_h} \Lambda^{Mf})(s_c + s_b + \nu_2) + \phi_2 \nu_3 \frac{p_f}{p_h}}{s_c + s_b + \nu_2 - \phi_2} \lesseqgtr 0 \quad (4.9)$$

In the case of the short-run equilibrium rate of net exports (b^*), the comparative static result is also ambiguous. However, it is transparent that a devaluation is more likely to improve the trade balance if the ML condition holds ($\nu_3 > 0$) and the stronger the contractionary effects on the rates of capacity utilization and accumulation ($\nu_2 \phi_4 r_f \Lambda^{ED} + \nu_2 \phi_5 \frac{p_f}{p_h} \Lambda^{Mf}$). Therefore, b^* can improve in the short-run due to lower absorption through the channels relating to the costs of external debt and imported capital. Even if the ML condition does not hold, the rate of net exports can increase if the contractionary effects are particularly strong.

$$b^* = \frac{(s_c + s_b - \phi_2)[(X_0 - M_0) + \nu_1 u_f + \nu_3 \frac{e p_f}{p_h}]}{s_c + s_b + \nu_2 - \phi_2} - \frac{\nu_2 (I_0 + \phi_1 \pi - \phi_3 r_h \Lambda^{DD} - \phi_4 e r_f \Lambda^{ED} - \phi_5 \frac{e p_f}{p_h} \Lambda^{Mf} + \phi_6 \tau)}{s_c + s_b + \nu_2 - \phi_2} \quad (4.10)$$

$$\frac{\partial b^*}{\partial e} = \frac{\nu_3 \frac{p_f}{p_h}(s_c + s_b - \phi_2) + \nu_2 \phi_4 r_f \Lambda^{ED} + \nu_2 \phi_5 \frac{p_f}{p_h} \Lambda^{Mf}}{s_c + s_b + \nu_2 - \phi_2} \lesseqgtr 0 \tag{4.11}$$

These short-run results are consistent with much of the literature that models the effects of a currency devaluation. For example, several scholars have formalized the contractionary effects when an economy depends on imported capital goods. The works of Buffie (1986), Branson (1986) and Gylfason and Schmid (1983) emphasize the cost channel associated imported capital, while the works of Ribeiro et al. (2017a), Lopez and Perrotini (2006), Taylor (2004) and Bhaduri and Marglin (1990) delineate the distribution channel. In other words, the latter scholarship argues that firms' mark-up rises as the cost of imported capital increases and in turn contracts the wage share, which produces contractionary effects. Unlike these works, income distribution is constant in the short-run in this model, so that short-run effects relate primarily to the cost channel. Other theoretical models illustrate the contractionary effects when an economy's private sector is exposed to foreign currency denominated debt (Kohler 2019; 2017; Krugman 1999; Van Wijnbergen 1986; Gylfason and Risager 1984). Kholer and Krugman contend that devaluation increases the risks of bankruptcy and interest payments when external debt is non-trivial and thus, contracts demand through a cost channel. However, Van Wijnbergen and Gylfason and Risager model wealth as a negative function of external debt, so that a devaluation reduces real wealth and output. In the context of the traditional literature, the short-run results show that a devaluation produces expenditure-reducing effects through the investment channel and ergo, increases the likelihood that a devaluation improves the trade balance (Lizondo and Montiel 1989). Expenditure-switching effects are weak in this model due to the assumptions of a fixed coefficient production function and that both domestic and imported consumer goods are imperfect substitutes.

4.2.2 The Monetary Economy in an Excess Reserve Regime

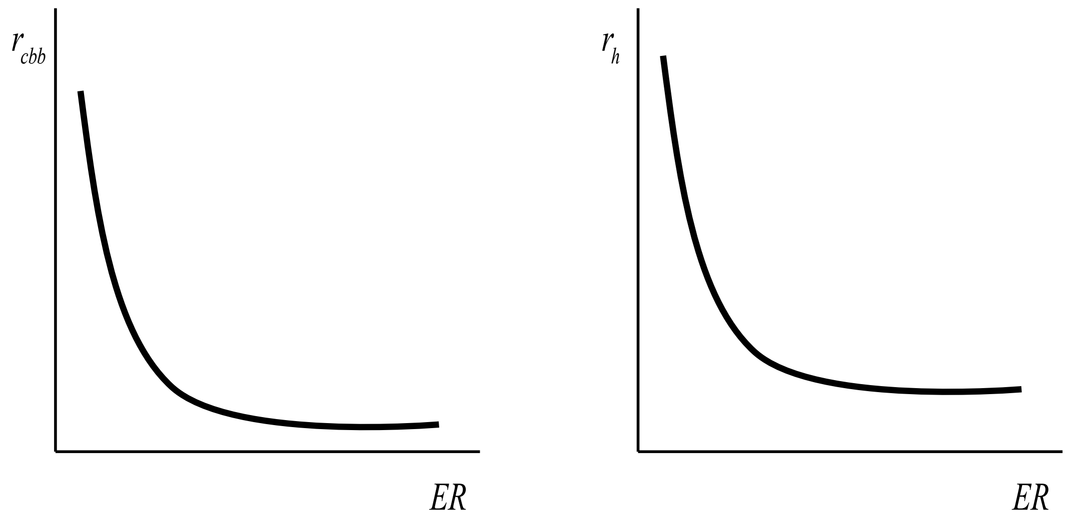
Given the short-run results, how does a devaluation affect the price level, income distribution and the loan rate over the medium-run? To answer these questions, the author models the home country's monetary economy. The financial sector is described by the following system of equations, where ER_D and ER_S are bankers' demand and supply for excess reserves respectively. The demand curve can be interpreted as banks's liquidity preference and based on Equation (4.12), banks' liquidity preference becomes perfectly elastic at a non-zero bond

(r_{cbb}) and loan rate (see Figure 4.1 below).

$$ER_D = a_0 + a_1 r_{cbb}^{-1} + a_2 r_h^{-1} + a_3 e \quad (4.12)$$

$$ER_S = b_0 + b_1 MC - b_2 \Lambda^{CBB} + b_3(\Delta IR) - b_4 RRR \quad (4.13)$$

Figure 4.1: Banks' Liquidity Preference in the Bond and Loan Markets



In other words, non-remunerated excess reserves and central bank bills (CBB) on the one hand and loans[3] on the other, become perfect substitutes over their respective non-zero range of interest rate. These relationships underscore an important feature of banking in developing and emerging economies which do not possess a globally traded currency. Khemraj (2014) and Moore and Craigwell (2002) contend that the non-zero lower bounds are reflective of an oligopolistic banking mark-up, risks and transaction costs in both the loan and bond markets.[4] The negatively slopped section of the liquidity preference curves illustrates that bankers' demand for excess reserves decreases as r_{cbb} and r_h increases. But what explains the persistent excess reserves in the banking system? In other words, why would excess reserves not be eliminated through the purchase of bonds, credit creation and investment in foreign assets?

[3]When CBB and loans become perfect substitutes from the perspective of banks, this implies that bankers are indifferent between holding central bank security and issuing loans/credit to borrowers. This should not be confused with the demand for loans by borrowers. Bankers' liquidity preference, which is perfectly elastic at a non-zero rate of interest, suggests that they are indifferent about holding three classes of assets: 1. CBB, 2. excess reserves and 3. loan assets.

[4]Given persistent excess reserves and banks' liquidity preference, it follows that banks' liquidity risks are low. However, there are potential solvency risks during periods of devaluations, if banks are exposed to foreign currency denominated liabilities.

According to Khemraj (2018), when no secondary market exists for central bank bills and the monetary authority limits the supply of CBB, banks are unable to unload their excess reserves through the bond market. Further, Khemraj (2010) notes that the non-zero lower bound in the loan market represents the minimum mark-up rate at which banks begin to offer credit. It follows that banks' oligopoly power and market risk premia traps the banking sector with excess reserves. Moreover, Khemraj (2009) finds evidence that banks in Guyana are unable to invest in foreign assets due to the monetary authority's accumulation of foreign exchange reserves. In other words, excess reserves persist because of the foreign currency constraint in developing and emerging economies. Worrell (1995) presents an additional explanation as to why a monetary regime of excess reserves might persist in equilibrium. He explains that illiquid markets increase the cost of shifting between cash balances and financial instruments, so that an equilibrium of excess reserves emerges. Altogether, these factors explain why excess reserves remain in monetary equilibrium and ergo, invalidates the reflux principle—that excess liquidity is eliminated through debt repayment and capital flight (Lavoie 2001)—in economies subject to these constraints.

Several additional points about a regime of excess reserves are noteworthy. The existence of said regime negates the need for an inter-bank money market or borrowing from the central bank's discount window. This has two fundamental implications: 1. Inflation targeting through the interest rate operating procedure (IROP) is highly ineffective and 2. Expansionary monetary policy through the use of the IROP is severely limited by the non-zero lower bound. Moreover, on account of the liquidity trap at the non-zero lower bound, growth in excess reserves are not inflationary. Finally, as outlined in Equation (4.12), a nominal devaluation increases the demand for excess reserves. Two principal factors motivate this specification. First, banks anticipate a rise in non-performing loans, so that greater demand for excess reserves is a means to strengthen their balance sheets. Second, to prevent flexible devaluations or intensified capital flight, banks curb credit creation through higher demand for excess reserves.

The supply function for excess reserves is shown in Equation (4.13) and is positively related to central bank's money creation (MC) and its accumulation of international reserves (IR) but inversely related to the ratio of central bank bills to capital stock ($\frac{CBB_s}{p_h K} \equiv \Lambda^{CBB}$) and the monetary authority's required reserve ratio (RRR). It is straightforward that money creation injects liquidity into the banking system as does the central bank's accumulation of foreign exchange. If the central bank chooses to sterilize or contract liquidity, it can increase the RRR

or simply increase the sale of central bank bills.

Equations (4.14) and (4.15) illustrate the central bank bond market, where Equation (4.14) is the inverse demand function. It shows that the monetary authority must offer bond rates in excess of the non-zero lower bound bond rate ($\bar{r_{cbb}}$), if it wishes to induce bankers to part with excess reserves and hold CBB. The parameter b_1 captures the degree by which bond rates must rise to induce higher demand for CBB. This specification is consistent with banks' liquidity preference shown in Figure 4.1 and highlights the limited power the monetary authority has in influencing the bond rate. Given that oligopolistic bankers have disproportionate influence on market rates, the IROP is not an effective means for the central bank to influence macroeconomic aggregates, e.g. the rate of inflation and output.

$$r_{cbb} = \bar{r_{cbb}} + b_1 \Lambda^{CBB} \tag{4.14}$$

$$\frac{CBB_S}{pK} \equiv \Lambda^{CBB} = c_0 + c_1 e \tag{4.15}$$

In turn, the supply of Λ^{CBB} increases with a nominal devaluation. The motivation behind this specification relates to the central bank's objective of preventing a flexible devaluation or capital flight as it undertakes a one-off nominal devaluation. It follows that liquidity policy is largely related to foreign exchange management by replacing the demand for foreign assets with central bank securities, rather than sterilizing liquidity in fear of inflationary effects. Downes and Khemraj (2019) investigate the Barbados case and posit that the central bank sells its securities to commercial banks and other buyers in order to create a domestically driven profit opportunity, instead of externally driven profits from foreign securities and to prevent black market trading in the local foreign exchange market. Downes and Khemraj refer to this discretionary liquidity management as the compensation mechanism, which differs from the automatic reflux or compensation mechanism described by Lavoie and Wang (2012) and Lavoie (2001). In the context of this model and consistent with the stylized facts, compensation is the one-sided sale of CBB, where investors hold the security until maturity.[5] This distinction is consequential to draw contrast with open market operations or sterilization, which requires a secondary bond market and a central bank that purchases and sells CBB. Given that the small open economy is in a monetary regime of excess reserves, the monetary authority is hardly in a position to repurchase bonds or inject liquidity. The cen-

[5]Former Governor of the Central Bank of Barbados explains that the so-called open market operations in Barbados are essentially the primary offerings of treasury bills (Worrell 1997).

tral point here is that compensation is largely a matter of policy and judgement rather than automatic forces in the secondary money market (Downes and Khemraj 2019).

Given Equations (4.14) and (4.15), the equilibrium bond rate and quantity sold are derived below. It is transparent that a currency devaluation increases both quantity and price in the bond market. These results follow logically from the idea that compensation can only take place if bankers are offered higher rates of return that exceed the non-zero lower bound rate.

$$r_{cbb}{}^{*} = r_{\bar{cbb}} + b_1(c_0 + c_1 e) \tag{4.16}$$

$$\frac{\partial r_{cbb}{}^{*}}{\partial e} = b_1(c_1) > 0$$

$$\Lambda^{CBB*} = c_0 + c_1 e \tag{4.17}$$

$$\frac{\partial \Lambda^{CBB*}}{\partial e} = c_1 > 0$$

The loan rate that clears the market for excess reserves can be derived by equating Equations (4.12) and (4.13) and substituting Equations (4.16) and (4.17) into the solution. This derivation departs from the monetary extensions of post-Keynesian models of growth and distribution that assume an exogenous interest rate (Lavoie 1999; Moore 1989; Kaldor 1985). It is closer to other post-Keynesian scholars like Palley (1996), Wray (1995) and Arestis and Howells (1996) but unlike these works, the endogeneity of r_h is related to the demand and supply of excess reserves rather than economic activity per se or demand for credit.

$$r_h{}^{*} = \frac{a_2\left[r_{\bar{cbb}} + b_1(c_0 + c_1 e)\right]}{b_0 + b_1 MC - b_2(c_0 + c_1 e) + b_3 \Delta IR - b_4 RRR - a_0 - a_1 - a_3 e} \tag{4.18}$$

The partial derivative in (4.19) illustrates that a nominal devaluation increases the loan rate that clears the market for excess reserves, where $\Gamma = b_0 + b_1 MC - b_2(c_0 + c_1 e) + b_3 \Delta IR - b_4 RRR - a_0 - a_1 - a_3 e$. Two mechanisms produce this result. First, a rise in e increases bankers' liquidity preference and this puts upward pressure on the loan rate. Second, a devaluation contracts the supply of excess reserves through the sale of central bank securities and this further increases the loan rate.

$$\frac{\partial {r_h}^*}{\partial e} = \frac{\Gamma(a_2 b_1 c_1) - \left[a_2\left(r_{c\bar{b}b} + b_1(c_0 + c_1 e)\right)(-b_2 c_1 - a_3)\right]}{(b_0 + b_1 MC - b_2(c_0 + c_1 e) + b_3 \Delta IR - b_4 RRR - a_0 - a_1 - a_3 e)^2} > 0 \tag{4.19}$$

These mechanisms that relate a nominal devaluation to the loan rate are unlike those advanced in the literature. For example, Bilson (1978) presents a dynamic model and concludes that a devaluation increases the loan rate in the medium-term, if it produces short-run expansionary effects. Bilson contends that a short-term expansion in output also raises the demand for money and thus, the rate of interest. By implication, contractionary devaluations lower the rate of interest. Other works look at the real balance effects, where a devaluation contracts the real money stock and wealth balances that engender an excess demand for loans and ergo, raises the loan rate (Lizondo and Montiel 1989). Under the assumptions of uncovered interest rate parity and an effective IROP, anticipated devaluations put upward pressure on the money market rate and by extension, the loan rate. But Turnovsky (1981) and Burton (1983) add the reminder that there are no interest rate effects if devaluations are unanticipated. In the case of the latter, Taylor (1981a) demonstrates that even unanticipated devaluations can increase the loan rate, if the economy is reliant on imported capital. Taylor argues that a devaluation increases the costs of capital imports in local currency and generates an excess demand for loans or working capital, thereby, raising r_h. Other mechanisms relate to risk premium, where a devaluation induces a higher policy rate to stem capital outflow but undermines firms' net-worth and their corresponding balance sheets. In turn, loan rates rise even further to account for the higher risk premium (Gatti et al. 2007). Given this short review, it is transparent that this chapter presents two new channels through which a nominal devaluation can increase the loan rate: 1. Downes and Khemraj (2019)'s compensation channel that contracts the supply of excess reserves and 2. An increase in banks' liquidity preference. It follows that a nominal devaluation unambiguously produces higher loan rates, irrespective of whether or not it is anticipated, its corresponding balance sheet effects and short-run impacts on the real economy.

It is important to emphasize here that recommendations of devaluations or transitions to flexible exchange rate systems are often supported by the thesis that these enhance monetary policy autonomy and thus, better enable the central bank to influence macroeconomic performance. However, if the economy in question is within a regime of excess reserves that are dominated by oligopolistic banks, the monetary authority may gain little policy flexibility.

This insight is particularly sobering in light of recent calls for GREXIT and similar abandonment of other fixed exchange rate regimes. Much depends on banks' liquidity preference, the degree of effectiveness of the IROP and the level of development of money markets.

4.2.3 Income Distribution and Prices

This section relaxes the assumption that income distribution is constant and presents a model of its behaviour in the medium-run. Equation (4.20) shows the time derivative of the real profit share, where $\Omega_1 > 0$ is an adjustment parameter and π^E is the expected profit share. In turn, as specified in Equation (4.21), π^E is a negatively related to the expected wage (α^E) and rent share (β^E).[6]

$$\dot{\pi} = \Omega_1(\pi^E - \pi) - p_h \tag{4.20}$$

$$\pi^E = 1 - \alpha^E - \beta^E \tag{4.21}$$

This model employs the post-Keynesian bargaining approach of the labour market where unions negotiate wage contracts with firms (Stockhammer 2011). The bargaining power of labour unions increases with the rate of capacity utilization and this in turn leads to higher wage demand (Equation 4.22). If the elasticity of substitution between capital and labour is less than one, a rise in the wage rate increases the wage share.[7] These effects are even stronger in this model given the assumption of a fixed coefficient production function, where capital and labour substitution effects are ruled out. The constant (ω_0) captures labour's exit options like unemployment benefits etc., that increases labour's bargaining power.

$$\alpha^E = \omega_0 + \omega_1 u \tag{4.22}$$

Equation (4.23) demonstrates that the expected rent share is a positive function of foreign assets-capital ratio, credit-capital ratio and the central bank bills-capital ratio, along with their respective rates of return, less the total income paid to depositors ($r_d \Lambda^D$). Total deposit-capital ratio is defined as $\frac{D}{p_h K} \equiv \Lambda^D$ and r_d is the deposit rate banks pay to depositors. The

[6] This specification omits the share of imported capital goods in the interest of presentation, since the model already adds a third income claimant—banker rent share. In standard formulation, the share of imported capital goods is exogenously given, which implies that no income group has any influence over its share, e.g. (Ribeiro et al. 2016). Its inclusion would not alter the results in any substantial manner but merely present the well established channel through which a devaluation can influence the profit share.

[7] See Rowthorn (1999) and Semieniuk (2017b) for evidence that the elasticity of substitution is less than one.

foreign asset-capital ratio (Λ^F) has two rates of return, e and r_f, to illustrate the point that a devaluation also increases bankers' rent income in local currency, given an existing stock of Λ^F.

$$\beta^E = \delta_0 + \delta_1(e + r_f)\Lambda^F + \delta_2 r_h \Lambda^{DD} + \delta_3 r_{cbb} \Lambda^{CBB} - \delta_4 r_d \Lambda^D \tag{4.23}$$

To fully specify the evolution of the real profit share, the author endogenizes the home country's price level (p_h). Equation (4.24) outlines the time derivative of p_h, where $\Omega_2 > 0$ is an adjustment parameter and p_h^E is home country's expected price level.

$$\dot{p_h} = \Omega_2(p_h^E - p_h) \tag{4.24}$$

Equation (4.25) shows that the expected price level is a positive function of the nominal exchange rate. This simplistic formulation narrows in on the importance of imported consumer and capital goods to the overall price level. The constant h_0 captures all other factors that might raise the expected price level.

$$p_h^E = h_0 + h_1 e \tag{4.25}$$

Substitution of Equation (4.25) into (4.24), yields the home country's equilibrium price level (p_h^*) when $\dot{p_h} = 0$. This derivation shows that a nominal devaluation raises the equilibrium price level (4.27).

$$p_h^* = h_0 + h_1 e \tag{4.26}$$

$$\frac{\partial p_h^*}{\partial e} = h_1 > 0 \tag{4.27}$$

Given the equilibrium price level, it is straightforward to solve for the equilibrium profit share at a constant price level and $\dot{\pi} = 0$. Substitution of Equations (4.21)-(4.23) and (4.26) into Equation (4.20), derives the equilibrium profit share (π^*), where $\chi = \delta_4 r_d \Lambda^D - \omega_0 - \delta_0 - h_0$.

$$\pi^* = 1 - \chi - \omega_1 u - \delta_1(e + r_f)\Lambda^F - \delta_2 r_h \Lambda^{DD} - \delta_3 r_{cbb} \Lambda^{CBB} - h_1 e \tag{4.28}$$

Since r_h, r_{cbb}, and Λ^{CBB} are endogenous variables, substitution of Equations (4.16)-(4.18) into (4.28), yields the extended equilibrium profit share consistent with constant prices and monetary equilibrium in a regime of excess reserves.

$$\pi^* = 1 - \chi - \omega_1 u - \delta_1(e + r_F)\Lambda^F - \delta_3\Big[\Big(r_{c\bar{b}b} + b_1(c_0 + c_1 e)\Big)(c_0 + c_1 e)\Big] - h_1 e$$
$$- \delta_2\Big[\frac{a_2\big[r_{c\bar{b}b} + b_1(c_0 + c_1 e)\big]}{b_0 + b_1 MC - b_2(c_0 + c_1 e) + b_3 \Delta IR - b_4 RRR - a_0 - a_1 - a_3 e}\Big]\Lambda^{DD} \quad (4.29)$$

The partial derivative in (4.30) shows that a nominal devaluation unambiguously reduces the equilibrium profit share through four channels, κ_1 to κ_4. In the interest of presentation, r_h^* is used instead of its complete specification and it is instructive to recall that $\frac{\partial r_h^*}{\partial e} > 0$.

$$\frac{\partial \pi^*}{\partial e} = \overbrace{-\delta_1 \Lambda^F}^{\kappa_1} - \overbrace{\delta_3\Big[b_1 c_1(c_0 + c_1 e) + c_1\Big(r_{c\bar{b}b} + b_1(c_0 + c_1 e)\Big)\Big]}^{\kappa_2} - \overbrace{h_1}^{\kappa_3} - \overbrace{\delta_2\Big(\frac{\partial r_h^*}{\partial e} > 0\Big)\Lambda^{DD}}^{\kappa_4} < 0 \quad (4.30)$$

The first channel (κ_1) lowers the equilibrium profit share through higher rent income in local currency. The higher the existing stock of foreign assets to capital ratio (Λ^F), the larger the increase in rent income share and the smaller is the profit share. The second channel relates to κ_2, which captures the increase in banker rent share through the purchase of central bank bills or securities. Banker rent share benefits from the twin increases in central bank bills and the corresponding bond rate. The third channel, κ_3, does not directly indicate a redistribution away from profits to banker rent share, it simply illustrates the price effect of a nominal devaluation that lowers the real profit share. Finally, κ_4 does illustrate another channel by which a devaluation redistributes income in favour of bankers' rent share. It highlights the distributive effects of a higher loan rate as a nominal devaluation is undertaken. The larger is the existing stock of domestic debt to capital ratio (Λ^{DD}), the stronger are the distributive effects in favour of banker rent share.

The last channel associated with κ_4 is consistent with several works that emphasize how r_h affects income distribution (Hein 2007; Ciccarone 1998; Panico 1985; Pivetti 1985). For example, Hein (2007) presents a Kaleckian model where distribution among wages, profits and rent are determined by firms' mark-up pricing. According to Hein, how the rate of interest affects distribution depends on the relative bargaining power of each income group. If firms' mark-up is interest inelastic (elastic), higher interest rates redistributes income away from profits (wages) toward rent income. Unlike the mark-up pricing approach to income distribution, the result in (4.30) shows that an increase in r_h redistributes income away from profits toward rent income but how it affects the wage share largely depends on how it influences the rate of capacity utilization (see Equation 4.22).

The result in (4.30) is in stark contrast to the larger literature on two-class models that formally demonstrate how a devaluation increases the profit share (Ribeiro et al. 2017a; Missio et al. 2017; Ribeiro et al. 2016; Blecker 2011; Fiorillo 2001; Blecker 1989; Krugman and Taylor 1978; Diaz-Alejandro 1963; Alexander 1952). In these works, firms' mark-up is modeled as a positive function of the real exchange rate, so that a real devaluation increases firms' market power. According to Blecker (1989) and Blecker (2011), a devaluation increases the relative costs of competing goods in international markets and this enables firms to increase their target mark-up or profit share. But given that the small open economy is a price taker in world markets, a devaluation offers little price competitiveness and thereby, undermines Blecker's mechanism. The finding in (4.30) also differs from the more general result that a devaluation can produce ambiguous distributional effects depending on the extent of international competition and how wages and domestic prices react (Bhaduri and Marglin 1990). It follows that the chapter contributes to the literature by identifying the precise conditions under which a devaluation unambiguously reduces the profit share. The following conditions must be satisfied to produce this result: 1. The monetary economy must be in a regime of excess reserves and 2. The banking sector must be dominated by oligopolistic banks that are in a liquidity trap at a non-zero lower bound in the bond and loan markets.

One exception to the literature on devaluation and distribution is Ribeiro et al. (2017a). They show in a general Keynesian-Kaleckian two-class model that a real devaluation reduces the profit share if the share imported intermediate inputs in total variable cost is high. They argue that firms must lower their mark-up factor to maintain price competitiveness as a devaluation increases the costs of imported capital. It follows that the result presented in (4.30) shows that the condition of a high share of imported capital is not necessary for a devaluation to lower the profit share. This contribution is closely related to Constantine and Khemraj (2018) but provides several extensions relating to model dynamics and monetary equilibrium in a regime of excess reserves. Constantine and Khemraj present a short-run post-Kaleckian/Keynesian model of bankers, workers and capitalists. In this set-up, bankers can induce a currency depreciation and increase rent income, since they are the dominant participants in the foreign exchange market. Thus, Constantine and Khemraj (2018) conclude that a currency depreciation reduces the profit share.

4.2.4 Medium-Run Equilibrium

This section derives the medium-run equilibrium rates of capacity utilization, capital accumulation and net exports. Substitution of Equation (4.18), (4.26) and (4.29) into Equation (4.6), yields the medium-run rate of capacity utilization (u^{**}). In the interest of presentation, π^* and r_h^* are used instead of their complete specifications but the denominator fully accounts for the effects of u on the profit share by the inclusion of $\omega_1\phi_1$.

$$u^{**} = \frac{\Psi + \phi_1\pi^* - \phi_3 r_h^*\Lambda^{DD} - \phi_4 e\, r_F\Lambda^{ED} - \phi_5\left(\frac{e p_f}{h_0+h_1 e}\right)\Lambda^{Mf} + \phi_6\tau + \nu_1 u_f + \nu_3\left(\frac{e p_f}{h_0+h_1 e}\right)}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} \tag{4.31}$$

Recall the following conditions, which demonstrate that a devaluation unambiguously contracts and increases the profit share and loan rate respectively.

$$\frac{\partial \pi^*}{\partial e} < 0$$

$$\frac{\partial r_h^*}{\partial e} > 0$$

Given these unambiguous findings, the author presents the medium-run comparative dynamic result for the equilibrium rate of capacity utilization. The partial derivative in (4.32) illustrates that a nominal devaluation has ambiguous effects on the medium-run rate of capacity utilization. However, as compared to the short-run result, there are additional contractionary effects through the channels of a lower profit share $\left(\frac{\partial \pi^*}{\partial e} < 0\right)$ and a higher loan rate $\left(\frac{\partial r_h^*}{\partial e} > 0\right)$. Further, as the price effects of higher consumer and capital imports are incorporated in the medium-run price level, the size of the real devaluation gets smaller. This implies that the real increase in the cost of imported capital is smaller as compared to the short-run result and that any short-run gains (losses) in price competitiveness are weakened (stronger).

$$\frac{\partial u^{**}}{\partial e} = \frac{\phi_1\left(\frac{\partial \pi^*}{\partial e} < 0\right) - \phi_3\left(\frac{\partial r_h^*}{\partial e} > 0\right)\Lambda^{DD} - \phi_4 r_f\Lambda^{ED} - \phi_5\left(\frac{(h_0+h_1 e)p_f - (e p_f)h_1}{(h_0+h_1 e)^2} > 0\right)\Lambda^{Mf}}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2}$$
$$+ \frac{\nu_3\left(\frac{(h_0+h_1 e)p_f - (e p_f)h_1}{(h_0+h_1 e)^2} > 0\right)}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} \lesseqgtr 0 \tag{4.32}$$

The comparative dynamic result that a devaluation can produce medium-run contractionary effects through a lower profit share is a novel contribution to the literature on growth and distribution in an open economy. In other scholarship that employs the mark-up pricing approach to distribution, the mark-up is elastic to the exchange rate, so that a devaluation increases the mark-up and the profit share. In these works, the contractionary effects relate to lower consumption demand as profit earners have a higher saving propensity (Ribeiro et al. 2017a; Missio et al. 2017; Ribeiro et al. 2016; Blecker 2011; Fiorillo 2001; Blecker 1989; Krugman and Taylor 1978; Diaz-Alejandro 1963; Alexander 1952). However, in this model, there are two contractionary effects relating to a lower profit share: 1. Lower investment demand and 2. Lower consumption demand as rent earners—bankers—have a higher saving propensity. Another novel contribution of this medium-run result is that it demonstrates how a nominal devaluation affects the loan rate and accounts for both its cost and distributive effects. As a nominal devaluation raises r_h^*, there are two contractionary effects: 1. A contraction of investment demand through higher cost of bank finance and 2. A contraction of investment demand through a lower profit share (internal finance). It follows that a nominal devaluation reduces firms' access to both internal and external sources of capital, deepening the contractionary effects.

It is instructive to recall the channels through which a devaluation reduces the profit share:

- Higher rent income in local currency, subject to bankers' existing stock of foreign assets to capital ratio (Λ^F)
- Higher rent income through compensation, subject to the bond rate (r_{cbb}) and the stock of central bank bills to capital ratio (Λ^{CBB})
- Higher rent income through an increase in the loan rate, subject to the existing stock of domestic debt to capital ratio (Λ^{DD})
- Higher price level reduces the real profit share.

Only the latter two channels are meaningfully subjected to the representative firm's mark-up factor. In other words, the mark-up pricing approach to income distribution omits two factors that lower the profit share: 1. Higher rent income in local currency due to banks' holding of foreign assets and 2. The sale of central bank bills to bankers (compensation). These twin factors demonstrate that bankers can earn economic rent from activities not related to credit creation. In other words, oligopoly banks can profit without intermediation and thus, impose contractionary effects. The principal insight here is that the theory of distribution matters for how exogenous factors affect distributional dynamics. For example, Lavoie (1995) shows that while the rate of interest contracts investment demand, it does not affect income distribution. Lavoie assumes that the mark-up factor is interest inelastic. However, in Kaldorian/Robinsonian models, where income distribution is determined by accumulation, a higher rate of interest not only lowers the rate of accumulation but also the profit share (Hein 2007). This result holds even if the mark-up is interest inelastic. It follows that the analysis of growth and distributional dynamics must fully appreciate all the key factors that affect income claimants, whether in the real or financial economy and whether or not these are reflected in firms' mark-up.

Substitution of Equation (4.31) into (4.3) and (4.5) derives the medium-run equilibrium rates of capital accumulation (g^{**}) and net exports (b^{**}).

$$g^{**} = \frac{(s_c + s_b + \nu_2 + \phi_1\omega_1)\Big[I_0 + \phi_1\pi^* - \phi_3 r_h^*\Lambda^{DD} - \phi_4 e\, r_f \Lambda^{ED} - \phi_5\Big(\frac{ep_f}{h_0+h_1 e}\Big)\Lambda^{Mf} + \phi_6\tau\Big]}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} + \frac{\phi_2\Big[X_0 - M_0 + \nu_1 u_f + \nu_3\Big(\frac{ep_f}{h_0+h_1 e}\Big)\Big]}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} \quad (4.33)$$

The comparative dynamic result of a devaluation on g^{**} remains ambiguous but there are additional contractionary effects relating to a lower and higher profit share and loan rate respectively. Since investment demand gets a greater weight in the equilibrium rate of accumulation, the additional contractionary effects are particularly pronounced.

$$\frac{\partial g^{**}}{\partial e} = \frac{\phi_2\nu_3\Big(\frac{\partial e p_f/p_h^*}{\partial e} > 0\Big)}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} + \frac{\Big[\phi_1\Big(\frac{\partial \pi^*}{\partial e} < 0\Big) - \phi_3\Big(\frac{\partial r_h^*}{\partial e} > 0\Big)\Lambda^{DD} - \phi_4 r_f\Lambda^{ED} - \phi_5\Big(\frac{\partial e p_f/p_h^*}{\partial e} > 0\Big)\Lambda^{Mf}\Big](s_c + s_b + \nu_2 + \phi_1\omega_1)}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} \lesseqgtr 0 \quad (4.34)$$

In turn, Equation (4.35) depicts the medium-run equilibrium rate of net exports (b^{**}) and its comparative dynamic result is similarly ambiguous.

$$b^{**} = \frac{(s_c + s_b + \phi_1\omega_1 - \phi_2)\Big[(X_0 - M_0) + \nu_1 u_f + \nu_3\Big(\frac{ep_f}{h_0+h_1 e}\Big)\Big]}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2}$$

$$- \frac{\nu_2\Big[I_0 + \phi_1\pi^* - \phi_3 r_h^*\Lambda^{DD} - \phi_4 e\, r_f \Lambda^{ED} - \phi_5\Big(\frac{ep_f}{h_0+h_1 e}\Big)\Lambda^{Mf} + \phi_6\tau\Big]}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} \qquad (4.35)$$

As compared to its short-run result, there are additional expansionary channels that increase the likelihood of an improvement in the external balance. Omitting concerns over the ML condition, a devaluation that contracts and raises the profit share and loan rate respectively, can compress absorption through lower consumption and investment demand. Collectively, these expenditure-reducing effects can improve the rate of net exports through the income/expenditure channel. Given the model's set-up of a fixed-coefficient production technology and price taking firms in world markets, devaluations are more likely to improve b^{**} through contractions in income rather than enhanced price competitiveness. It becomes a matter of political judgement if policymakers find it prudent to induce domestic income stagnation as a means to improve the external balance. In the case of chronic and prolonged external deficits caused by unsustainable/irresponsible consumption, a devaluation may indeed be well suited. However, if the objective of a nominal devaluation is to enhance competitiveness, the medium-run results show that a lowering of the rate of capital accumulation is more likely, which in turn undermines competitiveness, notwithstanding a faster rate of net exports. Ergo, it is crucial to ascertain the source of improvement in the external balance—enhanced competitiveness or income stagnation—before assessments can be conclusive.

$$\frac{\partial b^{**}}{\partial e} = \frac{\Big(\frac{\partial e p_f/p_h^*}{\partial e} > 0\Big)(s_c + s_b + \phi_1\omega_1 - \phi_2)}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2}$$

$$+ \frac{\nu_2\phi_3\Big(\frac{\partial r_h^*}{\partial e} > 0\Big)\Lambda^{DD} - \nu_2\phi_1\Big(\frac{\partial \pi^*}{\partial e} < 0\Big) + \nu_2\phi_4 r_f \Lambda^{ED} + \nu_2\phi_5\Big(\frac{\partial e p_f/p_h^*}{\partial e} > 0\Big)\Lambda^{Mf}}{s_c + s_b + \nu_2 + \phi_1\omega_1 - \phi_2} \lesseqgtr 0 \qquad (4.36)$$

These medium-run comparative dynamic results underscore the crucial importance of context in determining the impact of a nominal devaluation. The existing literature identifies several consequential factors for how a nominal devaluation affects distribution and output:

- Degree of substitutability between domestic and imported consumer and capital goods
- Price elasticities
- Demand regimes
- Relative bargaining power of labour and capital
- Share of imported capital goods in variable costs
- Extent of foreign currency denominated liabilities
- Extent of excess capacity.

This chapter adds the following to the literature:

- Degree of competition in the banking sector
- Size of bankers' foreign assets- and loan-capital ratios
- Whether or not the monetary economy is in a regime of excess reserves.

From the last item follows the monetary operation of compensation that increases banks' profitability without intermediation and this effect is intensified following a devaluation. Moreover, the liquidity trap at the non-zero lower bound, where excess reserves become perfect substitutes for loans and central bank bonds, indicate the enormous influence bankers have over the bond and loan rates. These particular features conspire to increase the loan rate and bankers' rent share as a direct consequence of a nominal devaluation and engender contractionary effects.

4.2.5 Technological Change

To investigate the long-run implications of a nominal devaluation, this section allows for the endogeneity of the rate of technological progress (τ). Assume that technical change is labour-augmenting and progresses incrementally to improve the existing processes of production. Equation (4.37) argues that a higher profit share increases the rate of technical change. The basic intuition is that investment in learning and R&D or firm-level adaptation of imported technologies, which enhance the rate of innovation, can only take place if firms have sufficient internal funds. This modeling approach is consistent with a well-established literature on firms' ability to self-finance R&D activities. Several theoretical works emphasize the profits-technololgy channel in post-Keynesian/Kaleckian and balance of payments constrained growth models (Missio et al. 2017; Ribeiro et al. 2016; Missio and Jayme 2012; Lima 2004; Fiorillo 2001).[8]

$$\tau = \sigma_0 + \sigma_1 \pi - \sigma_2 r_h - \sigma_3 T \tag{4.37}$$

The cost of bank finance (r_h) is added as an important factor that determines the rate of innovation. External finance becomes particularly important when incentives to innovate are high but internal resources are low. Finally, the rate of technical change is inversely related to the inverted technological gap (T), which is defined as the ratio of technological capabilities in the home and foreign country. It follows that τ captures the rate at which the home country closes the technological gap. As the latter narrows, there are fewer opportunities for technological imitation and adoption and weaker effects of knowledge spillovers and transfers, therefore, technical change slows down with convergence (T) (Porcile and Spinola 2018; Ribeiro et al. 2016; Cimoli and Porcile 2014; Verspagen 1991).

Given the equilibrium profit share and loan rate, it is straightforward to solve for the equilibrium rate of innovation—τ^*—that is consistent with equilibrium in the money market for excess reserves and stable income distribution at constant prices. Substitution of Equations (4.18) and (4.29) into Equation (4.37), yields the equilibrium rate of technical change.

$$\tau^* = \sigma_0 + \sigma_1 \pi^* - \sigma_2 r_h^* - \sigma_3 T$$

[8] This linear modeling of technological progress and income distribution is unlike the non-linear approaches associated with the works of Martins Neto (2017), Ribeiro et al. (2016) and Lima (2004). Martins Neto (2017) and Ribeiro et al. (2016) follow Lima (2004), who models the non-linear relationship between income distribution and technological change. Lima employs a post-Keynesian dynamic model where distribution matters for innovation due to its effects on incentives and resource availability. For example, while firms' incentive to innovate is high (low) when wage shares are high (low), the availability of internal funds is low (high). It follows that in Lima (2004), too low or high wage shares reduce the rate of technological change.

$$\tau^* = \sigma_0 + \sigma_1 \Big\{ 1 - \chi - \omega_1 u - \delta_1 (e + r_F) \Lambda^F - \delta_3 \Big[\Big(r_{c\bar{b}b} + b_1 (c_0 + c_1 e) \Big) (c_0 + c_1 e) \Big] - h_1 e$$
$$- \delta_2 \Big[\frac{a_2 \Big[r_{c\bar{b}b} + b_1 (c_0 + c_1 e) \Big]}{b_0 + b_1 MC - b_2 (c_0 + c_1 e) + b_3 \Delta IR - b_4 RRR - a_0 - a_1 - a_3 e} \Big] \Lambda^{DD} \Big\}$$

$$+ \sigma_1 \Big\{ \frac{a_2 \Big[r_{c\bar{b}b} + b_1 (c_0 + c_1 e) \Big]}{b_0 + b_1 MC - b_2 (c_0 + c_1 e) + b_3 \Delta IR - b_4 RRR - a_0 - a_1 - a_3 e} \Big\} - \sigma_3 T \quad (4.38)$$

Recall that $\frac{\partial \pi^*}{\partial e} < 0$ and $\frac{\partial r_h^*}{\partial e} > 0$, so that a nominal devaluation reduces the rate of innovation through lower retained earnings and higher cost of bank finance.

$$\frac{\partial \tau^*}{\partial e} = \sigma_1 \Big(\frac{\partial \pi^*}{\partial e} < 0 \Big) - \sigma_2 \Big(\frac{\partial r_h^*}{\partial e} > 0 \Big) < 0$$

$$\frac{\partial \tau^*}{\partial e} = \sigma_1 \Big\{ - \delta_1 \Lambda^F - \delta_3 \Big[b_1 c_1 (c_0 + c_1 e) + c_1 \Big(r_{c\bar{b}b} + b_1 (c_0 + c_1 e) \Big) \Big] - h_1 e - \delta_2 \Big(\frac{\partial r_h^*}{\partial e} > 0 \Big) \Lambda^{DD} \Big\}$$

$$- \sigma_2 \Big\{ \frac{\Gamma (a_2 b_1 c_1) - \Big[a_2 \Big(r_{c\bar{b}b} + b_1 (c_0 + c_1 e) \Big) (-b_2 c_1 - a_3) \Big]}{(b_0 + b_1 MC - b_2 (c_0 + c_1 e) + b_3 \Delta IR - b_4 RRR - a_0 - a_1 - a_3 e)^2} \Big\} < 0 \quad (4.39)$$

This result clearly illustrates that a nominal devaluation—which is modeled as a real devaluation in the short-run in this chapter—can have long-run effects, contrary to the proposition in the traditional literature (Thirlwall 1979; Bilson 1978). These scholars contend that long-run adjustment in prices, either through higher nominal wages or other variable costs, negate the short-run effects of a real devaluation. But as noted earlier, several theoretical models have endogenized technical change as a function of distribution and formalized the distributive effects of a real devaluation, thereby, undermining the traditional proposition. One contribution to the literature on endogenous technological change and income distribution, is that the model brings to the forefront distributional conflict in a three-incomes setting—profits, wages and rents. The finding in condition (4.39), qualifies the standard result in two-class models that show how a real devaluation can raise the profit share and the rate of technological progress (Missio et al. 2017; Ribeiro et al. 2016; Feijo and Lamonica 2013; Missio and Jayme 2012; Araujo and Lima 2007). Ribeiro et al. (2016) add an important note of caution to the thesis that devaluations reduce wage shares and engender technological change. Unlike the previous studies, Ribeiro and his co-authors present an aggregate balance of payments constrained growth model that formalizes a non-linear relationship between technological change and the wage share, along the lines of Lima (2004). They find that real devaluations have ambiguous effects on the wage share, thus retained earnings and the rate of innovation. This chapter adds to this note of caution, albeit through different mechanisms. Much of the literature that investigates the long-run effects of a real devaluation are preoccupied with the channel of retained earnings. They fail to consider the cost of bank finance and its relationship with the real exchange rate. This leads to the second contribution to the literature—the chapter identifies novel channels by which a real devaluation raises the loan rate but also demonstrates its short, medium and long-run effects. In the case of the latter, a real devaluation increases the cost of bank finance, which lowers the incentive to innovate and consequently, contracts the rate of technological progress.

4.2.6 Long-Run Equilibrium

This section derives the long-run equilibrium rates of capacity utilization, capital accumulation and net exports. Substitution of Equation (4.38) into (4.31), yields the long-run rate of capacity utilization (u^{***}). In the interest of presentation, τ^* is used instead of its complete specification but the denominator fully accounts for the effects of u on the equilibrium rate of innovation by the inclusion of $\phi_6\sigma_1\omega_1$.

$$u^{***} = \frac{\Psi + \phi_1\pi^* - \phi_3 r_h^*\Lambda^{DD} - \phi_4 e\, r_F\Lambda^{ED} - \phi_5\left(\frac{e p_f}{h_0+h_1 e}\right)\Lambda^{Mf} + \phi_6\tau^* + \nu_1 u_f + \nu_3\left(\frac{e p_f}{h_0+h_1 e}\right)}{s_c + s_b + \nu_2 + \phi_1\omega_1 + \phi_6\sigma_1\omega_1 - \phi_2} \tag{4.40}$$

Given the unambiguous finding of $\frac{\partial\tau^*}{\partial e} < 0$, the author presents the long-run comparative dynamic result for the equilibrium rate of capacity utilization. Consistent with the short- and medium-run results, the partial derivative in (4.41) illustrates that a nominal devaluation has ambiguous effects on the long-run rate of capacity utilization. However, as compared to both the short- and medium-run results, there is one additional contractionary effect through the channel of a lower rate of technological progress $\left[\phi_1\sigma_1\left(\frac{\partial\tau^*}{\partial e} < 0\right)\right]$. This increases the likelihood that a real devaluation is contractionary in the long-term.

$$\frac{\partial u^{***}}{\partial e} = \frac{\nu_3\left(\frac{(h_0+h_1 e)p_f-(e p_f)h_1}{(h_0+h_1 e)^2} > 0\right)}{s_c + s_b + \nu_2 + \omega_1\phi_1 + \phi_1\omega_1 + \phi_6\sigma_1\omega_1 - \phi_2}$$

$$+ \frac{\phi_1\left(\frac{\partial \pi^*}{\partial e} < 0\right) - \phi_3\left(\frac{\partial r_h^*}{\partial e} > 0\right)\Lambda^{DD} - \phi_4 r_f \Lambda^{ED} - \phi_5\left(\frac{(h_0+h_1 e)p_f-(e p_f)h_1}{(h_0+h_1 e)^2} > 0\right)\Lambda^{Mf} + \phi_6\sigma_1\left(\frac{\partial \tau^*}{\partial e} < 0\right)}{s_c + s_b + \nu_2 + \phi_1\omega_1 + \phi_6\sigma_1\omega_1 - \phi_2}$$

$$\lesseqgtr 0 \quad (4.41)$$

Substitution of Equation (4.40) into (4.3) and (4.5) derives the long-run equilibrium rates of capital accumulation (g^{***}) and net exports (b^{***}).

$$g^{***} = \frac{\phi_2\left[X_0 - M_0 + \nu_1 u_f + \nu_3\left(\frac{e p_f}{h_0+h_1 e}\right)\right]}{s_c + s_b + \nu_2 + \phi_1\omega_1 + \phi_6\sigma_1\omega_1 - \phi_2}$$

$$+ \frac{(s_c + s_b + \nu_2 + \phi_1\omega_1 + \phi_6\sigma_1\omega_1)\left[I_0 + \phi_1\pi^* - \phi_3 r_h^*\Lambda^{DD} - \phi_4 e r_f \Lambda^{ED} - \phi_5\left(\frac{e p_f}{h_0+h_1 e}\right)\Lambda^{Mf} + \phi_6\tau^*\right]}{s_c + s_b + \nu_2 + \phi_1\omega_1 + \phi_6\sigma_1\omega_1 - \phi_2} \quad (4.42)$$

The comparative dynamic result of a devaluation on g^{***} remains ambiguous but the likelihood that a real devaluation contracts the long-run rate of accumulation increases, due to the lower rate of innovation. Further, since investment demand gets a greater weight in the equilibrium rate of accumulation, the additional contractionary effect of a lower rate of technical change is particularly strong.

$$\frac{\partial g^{***}}{\partial e} = \frac{\phi_2 \nu_3\Big(\frac{\partial e p_f / p_h^*}{\partial e} > 0\Big)}{s_c + s_b + \nu_2 + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2}$$

$$+ \frac{\Big[\phi_1\Big(\frac{\partial \pi^*}{\partial e} < 0\Big) - \phi_3\Big(\frac{\partial r_h^*}{\partial e} > 0\Big)\Lambda^{DD} - \phi_4 r_f \Lambda^{ED} - \phi_5\Big(\frac{\partial e p_f / p_h^*}{\partial e} > 0\Big)\Lambda^{Mf} + \phi_6 \sigma_1\Big(\frac{\partial \tau^*}{\partial e} < 0\Big)\Big]}{s_c + s_b + \nu_2 + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2}$$

$$\Big(s_c + s_b + \nu_2 + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1\Big) \lesseqgtr 0 \quad (4.43)$$

Equation (4.44) depicts the long-run equilibrium rate of net exports and its comparative dynamic result is similarly ambiguous.

$$b^{***} = \frac{(s_c + s_b + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2)\Big[(X_0 - M_0) + \nu_1 u_f + \nu_3\Big(\frac{e p_f}{h_0 + h_1 e}\Big)\Big]}{s_c + s_b + \nu_2 + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2}$$

$$- \frac{\nu_2\Big[I_0 + \phi_1 \pi^* - \phi_3 r_h^* \Lambda^{DD} - \phi_4 e r_f \Lambda^{ED} - \phi_5\Big(\frac{e p_f}{h_0 + h_1 e}\Big)\Lambda^{Mf} + \phi_6 \tau^*\Big]}{s_c + s_b + \nu_2 + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2} \quad (4.44)$$

The condition in (4.45) illustrates that a lower rate of technological progress dampens investment demand and increases the likelihood that the rate of net exports increases in the long-term. As explained in previous sections, this result is likely through the expenditure-reduction channel.

$$\frac{\partial b^{***}}{\partial e} = \frac{\Big(\frac{\partial e p_f / p_h^*}{\partial e} > 0\Big)(s_c + s_b + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2)}{s_c + s_b + \nu_2 + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2}$$

$$- \frac{\nu_2\Big[\phi_3\Big(\frac{\partial r_h^*}{\partial e} > 0\Big)\Lambda^{DD} - \phi_1\Big(\frac{\partial \pi^*}{\partial e} < 0\Big) + \phi_4 r_f \Lambda^{ED} + \phi_5\Big(\frac{\partial e p_f / p_h^*}{\partial e} > 0\Big)\Lambda^{Mf} + \phi_6 \sigma_1\Big(\frac{\partial \tau^*}{\partial e} < 0\Big)\Big]}{s_c + s_b + \nu_2 + \phi_1 \omega_1 + \phi_6 \sigma_1 \omega_1 - \phi_2}$$

$$\lesseqgtr 0 \quad (4.45)$$

4.3 Conclusion

This chapter presents a three-period post-Kaleckian model with three sources of income: wages, profits and rents, to demonstrate the dynamic effects of a real devaluation. The model accounts for the profit share, loan rate, foreign denominated liabilities, imported capital and the rate of technological progress. The chapter finds that the contractionary effects of a real devaluation increases in the short, medium and long-run. In the short-period, when prices and distribution are held constant, contractionary effects relate to higher costs of imported capital goods and foreign interest payments. This is a standard result for open economies with foreign liabilities.

Several novel contributions are derived in the chapter's medium-run results. In this period, prices, distribution and the loan rate are endogenous and uniquely related to the monetary economy. The latter is modeled as a regime of excess reserves, where bankers' liquidity preference for excess reserves and central bank bonds and loans become perfect substitutes at non-zero rates of interest. Moreover, bankers are assumed to hold foreign assets and central bank bonds, with price setting power in both the loan and bond markets. In the case of the latter, the monetary authority is primarily interested in managing excess reserves for the purpose of an orderly foreign exchange market. In the medium-term, a devaluation has several consequential effects for the loan rate and the profit share. First, a devaluation increases bankers' liquidity preference and this puts upward pressure on the loan rate. Second, a devaluation contracts the supply of excess reserves through the sale of central bank securities and this further increases the loan rate. Since bankers also profit from credit creation, an increase in the loan rate increases bankers' rent share and lowers the profit share. Moreover, bankers' income also increase on account of a higher bond rate and larger holdings of central bank securities. Further, a devaluation increases banks' profitability of foreign assets in local currency. These medium-run responses engender contractionary effects for the rates of capacity utilization and capital accumulation through the cost and distribution channels. A lower profit share and higher loan rate contract investment demand and higher rent share lowers overall consumption due to bankers' higher savings rate.

In the long-period, the rate of innovation is determined by retained earnings (profit share) and the cost of bank finance (loan rate). Given the medium-run findings, a devaluation lowers the rate of technological progress and by extension, the long-run rates of capacity utilization and capital accumulation. It follows that the contractionary effects of a devaluation increases through time when oligopolistic banks dominate an economy trapped in a regime of excess reserves. The implication of dynamic contractionary effects is that the rate of net exports increases, in other words, a regime of domestic demand stagnation co-exists with improvements in the external balance. Crucially, growth in the rate of net exports is the dubious reward for expenditure-reduction effects, on account of a lower and higher profit share and loan rate respectively, rather than growth in competitiveness. In fact, as the long-period result shows, long-run growth is unambiguously compromised through a lower rate of innovation.

The central policy insight of the model is that the decision to exit currency unions, undertake a real devaluation or adopt flexible exchange rate regimes, must be based on sound assessments of the particular country's context. The established literature highlights several conditional factors that determine the effects of a devaluation: price elasticities, degree of factor substitutability, demand regimes, degree of import penetration, extent of excess capacity and foreign liabilities. This work demonstrates that prospective devaluers must also consider the degree of competition in their banking sector, size of bankers' foreign assets- and loan-capital ratios and whether or not their economy is in a regime of excess reserves.

Conclusion

The purpose of this dissertation is to demonstrate how technological gaps and differences in income distribution affect regional cohesion in an Economic and Monetary Union and the possible effects of an exit from the latter. Below I highlight the main contributions of each chapter.

Chapter 1 summarizes the main themes in the balance of payments constrained growth literature. Namely, its historical origins, the elasticity pessimism and relative price adjustments, capital flows and endogenous trade elasticities. The review is partial to aggregate models but where it is instructive, multi-sectoral models are discussed. One limitation of this review is that it omits criticisms raised against the balance of payments constrained growth model and the corresponding replies, but the interested reader is encouraged to consult McCombie (2011) for extensive details.

Chapter 2 contributes to the literature on technological gaps and balance of payments constrained growth by developing a theoretical framework that accounts for the ambiguous effects of capital inflows on demand and balance of payments constrained growth. The model shows that when a technological gap exists between two countries in an Economic and Monetary Union (EMU) and it exceeds a critical threshold, capital flows toward the technological laggard deteriorate its production structure and reduce its balance of payments constrained growth rate. However, these results are reversed when the technological gap between countries falls within a convergence range. Capital flows are consequential to the catching-up process because the evolution of the technological gap depends on the Kaldor-Verdoorn effect. These findings have significant implications for EMUs and other regional groupings that aspire to deeper economic integration. First, the initial size of the technological gap between frontier and laggard economy is the principal determinant of whether closer economic integration promotes convergence or divergence. It follows that potential members of EMUs must pass the litmus test that specifies the maximum distance a member country can be from the frontier economy. This approach to integration limits the possibility of technological polarization and therefore, maintains community cohesion. Second, the analytical results show that expansionary policy in the frontier country is inadequate to promote technological convergence when the initial technological gap is significant. Only technology policy in the laggard economy can promote technological convergence.

Chapter 3 makes the case that five conditions are sufficient to produce technological polarization between members of an EMU. First, a technological gap must exist between countries, second, the laggard economy must have a more unequal distribution of income, third, there must be no fiscal union that governs the EMU, fourth, the laggard economy lacks a domestic capital goods producing sector and finally, a higher wage share must reduce the rate of technological progress. When these conditions hold, this chapter formally demonstrates that the growth-equality tradeoff is binding for the technological laggard. The chapter also underlines the point that the tradeoff is partly imposed by design. In this work, the economic policy framework of the EMU imposes stringent limits on debt and deficits without any compensatory mechanisms like a fiscal union or union-wide cohesion or technology policy. Given this straitjacket of an economic policy framework, laggard economies are promised the tale of convergence but experience technological divergence that undermine long-run growth. The central policy implication, whether at the level of an EMU or world economy, is that a union-wide technology policy is required to promote economic convergence. For example, the big tradeoff becomes less binding if the EMU or world organizations provide for investments in technological innovation and emulation that assist laggard economies in the catching-up process.

Chapter 4 looks at the growth and distributional effects of a real currency devaluation, say an exit from an EMU. In each period—short, medium and long-run—a real devaluation becomes increasingly contractionary. A noteworthy feature of the model is its approach to the monetary economy: bankers are assumed to have market power in both the loan and bond markets and liquidity preference for excess reserves that become perfect substitutes for loans and central bank bonds at non-zero rates of interest. As it relates to policy, the model argues that prospective devaluers must consider the degree of competition in their banking sector, size of bankers' foreign assets- and loan-capital ratios and whether or not their economy is in a regime of excess reserves. In the latter case, monetary authorities routinely sell central bank bonds to commercial banks to displace their demand for foreign assets as a means to maintain an orderly foreign exchange market (Downes and Khemraj 2019). This has the obvious distributional effect of raising banker rent share, which induces contractionary effects.

Overall, this dissertation presents three formal theoretical models of regional integration, with particular reference to the case of the Eurozone. I argue that the convergence criteria of debt, deficits and inflation targets etc., were largely misplaced as more fundamental asymmetries relating to income distribution, technological capabilities and demand regimes were unaddressed. I formally demonstrate that regional divergence and crises are inevitable when demand regimes differ and the initial size of the technological gap and differences in income distribution exceed a critical threshold. These findings lead to two principal policy conclusions: 1. Convergence criteria for EMUs must include demand regimes, technological gaps and income distribution and 2. Absent these convergence criteria, a Fiscal Union or Regional System of Innovation is necessary to arrest inevitable polarization and regional crises.

These theoretical models readily lend themselves to empirical application. First, chapter 2 presents two testable hypotheses within the context of regional groupings: 1. Capital inflows engender deindustrialisation in the laggard economy and 2. A technological gap beyond a critical threshold produces divergence in rates of economic growth. Future work can estimate the effect of capital inflows on manufacturing value added for laggard economies in say, the Pacific Alliance. Also, several empirical studies are needed to estimate the maximum technological gap allowable for economic convergence. This involves estimating a growth model that accounts for a non-linear specification of the technology gap, which can be proxied by several indices including the ratio of labour productivity between frontier and laggard economy. Second, chapter 3 argues that empirical growth models must control for the interaction effect among inequality, consumption and the technological gap. Absence this approach, empirical works will not capture the growth-inequality tradeoff in laggard economies. Finally, chapter 4 outlines several channels through which devaluations can be contractionary. Future empirical work that tests for the growth effects of a nominal devaluations must control for the degree of competition in the banking sector, size of bankers' foreign assets- and loan-capital ratios and whether or not the economy is in a regime of excess reserves. Further, interaction effects can verify which channels are more important.

On the theoretical front, much research is needed on the appropriate form/s of regional integration for developing and emerging economies—e.g. some form of production integration as distinct from the European Model—with intra-regional distributional conflict at the centre of the agenda.

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