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## Demand-led Industrialisation Policy in a Dual-Sector Small Balance of Payments Constrained Economy

Önder Nomaler, Danilo Spinola & Bart Verspagen

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## Abstract

This article models the process of structural transformation and catching-up in a demand-led Southern economy constrained by its balance of payments. Starting from the Sraffian Supermultiplier Model, we model a dual-sector small open economy divided between traditional and modern sectors that interacts with a technologically advanced Northern economy. We propose two (alternative) autonomous elements that define the growth rate of this demand-led economy: government spending and exports. Autonomous government spending plays a central role in stimulating demand, and thus is a source of growth of the modern sector. Productivity adjusts to the growth rate of output, given by the growth rate of autonomous expenditure. Drawing from the Structuralist literature, the technologically laggard Southern economy catches up by absorbing technology from the Northern economy, potentially closing the technology gap. The gap affects the income elasticity of exports, bringing a supply-side mediation to the growth rates in line with the Balance of Payments Constrained Model. We observe that a demand-led government policy plays a central role in structural change, pushing the modern sector to a take-off. Also, the economy is stable in terms of capacity utilisation and modern sector employment.

Keywords: Industrialisation, Catching-up, Balance of Payments, Sraffian Supermultiplier

JEL: O41, E12, E61

* United Nations University - Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-Merit). nomaler@merit.unu.edu
** Birmingham City University, UNU-Merit & University of Johannesburg. spinola@merit.unu.edu
*** Maastricht University & UNU-Merit. verspagen@merit.unu.edu

## 1. Introduction

The process of structural transformation involves moving from a dominance of traditional sectors to modern sectors of production. Here, "traditional sectors" refer to economic activities with low (or no) productivity growth that can be undertaken without much capital investment or formal education. Subsistence farming is a typical example, but also certain services activities in an urban context, such as street vending, fall under this heading. The "modern sector" consists of manufacturing, where productivity growth can be high and investment in physical and human capital is necessary, along with some of the more dynamic services sectors such as telecommunications (Lavopa and Szirmai, 2018). Thus, since the (first) Industrial Revolution, structural transformation has been connected directly with productivity increases, urbanisation, and moving from primary to manufacturing activities (Deane, 1979). These ideas can be traced back to Lewis (1954), and are now prominent in thinking about development.

The industrial revolution emancipated some societies from the Malthusian trap (Kögel & Prskawetz, 2001), generating productivity growth, increases in wages, and improvements in science and in life conditions (increased life expectancy, educational levels) (Hartwell, 2017). But this process has been quite uneven around the globe (Fagerberg, 1994) and, while some countries have managed to achieve a strong process of structural transformation, many other economies in developing regions still struggle to start and advance their own process of catching up (Fagerberg & Godinho, 2004). Thus, how economies can manage to leave a pre-industrial fully traditional economy behind, and move towards the constitution of modern high-productive sectors, has become a crucial question, with deep policy impact.

Some features in the process of structural transformation have shown a degree of commonality. Laggard economies that successfully catch up (as the case of South Korea) are the ones that have managed to absorb and adapt foreign technology (Cimoli & Porcile, 2014; Cimoli et al., 2019). The recent experiences of catching up in developing economies are usually connected to a strong government presence, as we see in China. Countries that have developed a strong modern sector have managed to relax their external constraints by diversifying the productive structure, and increasing their growth rates to be compatible with balance-of-payments constraints (Thirlwall, 1979; Sasaki, 2021).

In terms of policy, a prominent idea is that of the so-called developmental state (Wade, 2018), which, broadly speaking, refers to a government that takes an active and leading role in organising structural transformation. The cases of South East Asian nations such as Japan, South Korea and Taiwan, which realised quick structural transformation and the associated rapid economic growth, are seen as key example of this type of policy. In the idea of the developmental state, the emphasis lies mostly on supply-side policies, for example aimed at promoting technological learning, often through the adoption of foreign knowledge, the selection of specific sectors as policy targets, and stimulating exports.

In this paper, we want to analyse the potential influence of a demand-led policy for structural transformation, or industrialisation. The idea is that the development of a modern sector may not only be stimulated by foreign demand (exports), but also by domestic demand. Domestic demand may work through the wages of workers in the modern sector (i.e., a multiplier process), but government demand for modern-sector products may reinforce this effect. Our research question is therefore whether a demand-led policy for structural transformation (or industrialisation) may work and, if so, under which circumstances, and how will it influence the growth rate of the economy. Although our approach will not address the issue of supply-side policy, we do not want to suggest that supply-side policy is unimportant. We only want to (theoretically) explore the possibility of a demand-led policy, and propose that supply-side policy will always remain an important part of industrialisation.

Thus, we construct a model of structural transformation based on the Sraffian Supermultiplier Model (SSM; Freitas & Serrano, 2015), which offers a demand-led long-run growth framework that has recently gained momentum. The SSM is a macroeconomic model with a fully endogenous investment function (accelerator mechanism) that (a) increases the traditional Keynesian multiplier, generating higher multiplicative effects of autonomous spending, and (b) proposes that firms plan their production capacity with reference to a long-run capacity-utilisation rate.

We expand the SSM model by splitting the economy into a dual-sector structure composed of a low-productivity traditional sector and a modern, advanced sector. This part of our model is inspired by Lavopa (2015). From an initial situation in which the economy consists almost entirely of the traditional sector, we observe, under certain conditions (that we discuss in this paper), transition dynamics towards structural modernisation. Furthermore, we expand the original SSM model in the context of a Southern small open economy that interacts with the rest of the world through (1) international trade (imports and exports) and (2) absorption of technological knowledge, as the Southern economy is a technologically laggard as in the structuralist framework (Cimoli & Porcile, 2014). The presence of a technological gap, however, creates important catching-up opportunities (Verspagen, 1992; Lee & Malerba, 2017). Also, this Southern economy (and all economies) needs to be balanced in terms of its external sector, as it constantly suffers from balance of payments constraints, which allow us to include elements from the Balance of Payments Constrained model (BPCM) (Thirlwall, 1979).

In our model, government plays a central role in a demand-led policy, facilitating the development of a modern sector for it to take off. This goes in the same direction as Deleidi and Mazzucato (2019) and Freitas and Christianes (2020). Without government autonomous spending, the economy stays trapped in a low share of the modern sector.

The paper is organized in the following way: after this introduction, section 2 presents a brief literature review. In section 3, we introduce our model. In section 4 we present the steady state growth rates (there are four possible steady states) and some simulation results that illustrate the working of the demand-led industrialisation policy. Section 5 discusses the results in light of the debates, as well as the specificities of the model. Finally we conclude the paper in Section 6. An appendix gives the derivation of the steady states.

## 2. Literature Review

### *2.1. Dual sector economy*

The process of economic development in industrial economies involves a strong sectoral reallocation towards dynamics activities. Lewis (1954) observed and modelled the process of structural transformation, which gave rise to the dual-sector dynamic model, focused on the transition from a traditional, low-productivity agricultural sector to a modern, industrial urban sector. In the Lewis model, economies start from a pure traditional sector, and the emergence of an endogenous dynamic of capital accumulation gives rise to a modern sector, absorbing employment in activities with higher productivity, thereby increasing the average productivity of the economy.

The central role of manufacturing as a driver of economic growth has recently been reinforced by authors such as Rodrik (2016) and Szirmai (2012). This debate is central when dealing with developing economies. While some economies in Africa and Asia, such as Somalia, Ethiopia and Kenia, are trapped in low development with a very large traditional primary sector (Felipe et al., 2012), some other economies, especially in Latin America, have observed high urbanisation. However, this movement was partial, and was not followed completely by the widespread absorption of modern activities. This gave rise to literature on the middle-income traps (Felipe et al., 2012; Andreoni & Tregenna, 2020), as some of these economies now suffer from premature deindustrialisation (Rodrick, 2016; Tregenna, 2016). As observed in the structuralist theory, urbanisation in developing economies has resulted in the emergence of a large informal sector, mostly situated in the service sector (Lavopa, 2015). A high informality and the predominance of traditional activities in cities strengthen inequality, being the source of the widespread emergence of slums and other marginalised urban structures (Marx et al., 2013).

Lavopa (2015) and Lavopa and Szirmai (2018) propose an update to the concepts of modern and traditional in the dual-sector framework of the Lewis model. The authors split the service sector by the degree of productivity of each sub-sector, labelling those as modern or traditional sectors. Using this new dichotomy, we are able to capture in a unified framework the problem of structural transformation, detaching it from a classical view mostly related to urbanisation.

A dual-sector economy shows, through structural transformation, the transition and dynamic evolution of an economic system. However, that transition to a modern economy is far from automatic and under certain circumstances it may not occur, as we see in the literature on development traps (Felipe et al. 2012; Andreoni & Tregenna, 2020). The lack of conditions to allow for a widespread process of structural transformation creates barriers to the transition, while the economies stay trapped in traditional, low-tech activities. The way to overcome these barriers will then depend on the institutional and structural conditions of the economy regarding the external sector, and the role of government as a development agent in the process.

*2.2. External Sector and Balance of Payments Constraints*

The role of the external sector in developing economies has long been stressed by the structuralist literature. Prebisch (1950) highlights the relevance of the global dynamics in a centre-periphery dynamics. In a stylised simple explanation, the North is the locus of endogenous technological change, while the South is technologically laggard and absorbs the technology produced overseas. The global environment fosters the specialisation of the South in low-tech primary (traditional) goods, while the North produces and exports manufactured (modern) goods. The result is the emergence of uneven development caused by distinct price dynamics, as traditional goods tend to become cheaper then modern goods, leading to a tendency of decline in the terms of trade.

The structuralist theory, highlighting the central role of international dynamics, is then complementary to balance-of-payments constraint theories. According to the literature on development traps, one of the strongest barriers to growth and development arises from the dynamics of the balance of payments. That is especially true for developing economies that cannot finance themselves internationally in their own currency. The before-mentioned problem has been discussed deeply since the seminal works on the Balance-of-Payments Constrained Model (BPCM) developed by Thirlwall (1979), Thirlwall and Hussain (1982), and McCombie and Thirlwall (2004) (see an extensive review in Blecker & Setterfield, 2019).

In the BPCM, growth is constrained in the long run by the need for stability in the external sector. As expressed by its main authors (Thirlwall, 1979; McCombie, 2012), in the long run, economies cannot have an explosive pattern of depreciation in their real exchange rate, so that price cannot act as a long-run adjustment (with the exception of the cases of hysteresis). From this perspective, all adjustment comes from quantities and adjusting the domestic growth rate, which reacts to foreign growth through the ratio between income elasticity of demand for exports and imports, giving Thirlwall's law. The literature on the BPCM has been a central contribution of the Keynesian tradition, with relevant empirical evidence, as can be observed in the reviews by Blecker and Setterfield (2019) and Blecker (2021).

Authors in the Structuralist literature have used Thirlwall's law as a representation of the equilibrium long-run growth rate in developing economies (Cimoli & Porcile, 2014). These authors link it with the evolutionary discussion on the economics of innovation though the endogenisation of the income elasticity ratio (Lavopa, 2015; Porcile & Spinola, 2018). In this sense, the income elasticities of demand for exports and imports are observed in terms of the degree of diversification of the economy, and the degree of technological capabilities. Countries that have a higher income elasticity of demand for exports are the ones that export more advanced manufactured products, with more embedded knowledge and a higher degree of complexity.

### *2.3. The Sraffian Supermultiplier Model (SSM)*

In order to understand the growth conditions in the long run, we discuss the Sraffian Supermultiplier Model (SSM). The SSM approach consists of a demand-led growth model initially proposed by Freitas and Serrano (2015). In the SSM macroeconomic model, investment is fully endogenised, and the role of demand in growth is reduced to a single parameter, the growth rate of autonomous consumption demand. The baseline proposes that the capacity utilisation rate is a strategic decision of the firm. Firms aim at maintaining a certain degree of idle capacity, allowing them to react to changes in the demand conditions. In the long run, capacity utilisation converges to an exogenous rate. The model stabilises the relationship between productive capacity and aggregate demand by adjustments of the marginal propensity to invest. Because this propensity is an endogenous variable, it enters the multiplier that determines the short-run level of output, resulting in the term supermultiplier.

In the SSM, investments follow a pure accelerator mechanism (capital accumulation induced by income), with no autonomous component. Consumption (either private or public) has an autonomous component that grows at an exogenous growth rate. The short-run level of output adjusts to make savings equal to investment ex-post. Growth is demand-led not only in the short, but also in the long run. Finally, economic growth is equal to the exogenous growth rate of autonomous consumption demand, and capital accumulation (given the equilibrium utilisation rate) converges to this rate.

The SSM tradition currently offers a number of alternative sources for the exogenous rate of autonomous demand that determines the growth rate of the economy, and that include workers' autonomous consumption financed out of credit (Freitas & Serrano, 2015) as part of the wealth of the workers (Brochier & Silva, 2019), capitalists' consumption (Lavoie, 2016), subsistence consumption, including an unemployment benefits system (Allain, 2019), government expenditures (Allain, 2015), exports (Nah & Lavoie, 2017), and R&D investments (Caminati & Sordi, 2019). We develop our model based on some of these contributions, which include others such as Skott et al. (2021).

The SSM has recently been developed for an open economy. Nah and Lavoie (2017) offer an SSM in which the autonomous component comes from exports. However, the matter of balance-of-payments constraints is not developed in this literature, which opens the space to link the SSM tradition with the BPCM literature.

*2.4. Industrial Policy and the Developmental State*

Industrial policy is often seen as the main way of stimulating the industrialisation and modernisation of developing economies (e.g., Nelson & Pack, 1999; Cimoli et al., 2009). One way in which this can be done is via the so-called developmental state (e.g., Wade, 2018). The idea of the developmental state relies on the idea that markets are not vectors of structural change, but rather of economic specialisation (Chang, 1994). In order to advance with a process of structural change (industrialisation and an increase in modern activities), developing economies need to rely on strong government coordination, goal setting and mobilisation of private actors through government policy. Despite some failures, the main countries that have managed to catch up relied on developmental policies (Altenburg, 2011), as in the case of South Korea, Taiwan and Singapore (Wade, 2018).

The debate on industrial policy has been controversial, with a recent resurge (Aiginger & Rodrik, 2020), but it enters as a fundamental institutional element to lead to the process of catching up and structural change in developing economies (Andreoni & Chang, 2019; Landesmann & Stöllinger, 2019; Ocampo & Porcile, 2021). The need to create an institutional framework and direct resources to the construction of modern sectors has been shown in the literature as being fundamental in the transition from a low- and low middle-income country to a middle- or high-income country, and the state, in its developmental face (Caldentey, 2008), has played a central historical role in this process.

*2.5. Demand and central role of government*

The role of government is stressed particularly in the Keynesian tradition (Blecker & Setterfield, 2019), acting as an injection of demand into a system that suffers from a negative spiral of demand, caused by a fall in expectations in a monetary economy and in which Say's law is not valid (Davidson, 1972). This view is centred on the short-run mechanisms that lead the economy to a crisis, and then governmental spending acts as way to recompose demand and expectations.

The role of government spending in growth has been well developed by authors associated with a Keynesian framework (Kaldor, 1957; Blecker & Setterfield, 2019) since the Harrod-Domar model. The SSM enters into this debate, offering a theoretical perspective to observe the effects of government spending not only on recomposing demand, but also in defining long-run growth (Freitas & Serrano, 2015).

Also it is associated more with the evolutionary tradition, the role of government was also developed by the framework of mission-oriented policies (Mazzucatto, 2018), acting as an entrepreneurial state, funding research and creating investment projects that foster innovative activities (Mazzucatto, 2011). This framework has been associated recently with the SSM by Deleidi and Mazzucato (2019, 2021). Government spending in R&D acts as the autonomous component that ends up, through the SSM mechanisms, defining the long-run growth possibilities of the system.

## 3. Model

We consider a dually-structured Southern economy, with a modern and a traditional sector, which interacts with the rest of the world through imports and exports, in line with Nah and Lavoie (2017). Although both the modern and the traditional sector exist in the country, the traditional sector dominates the economy, and the question we pose is how a demand-led government policy can increase the share of the modern sector in the economy. We specify, analyse and simulate the model in discrete time.

In the traditional sector, workers consume what they produce, i.e., although the sector is counted in GDP, there are no savings, no investment, no imports and no exports. In this setting, as in the original Lewis approach, we only need to consider the role of the traditional sector as an absorber of workers who cannot find employment in the modern sector. Thus, we start the model exposition by writing the standard macroeconomic income identity, which holds for the modern sector irrespective of the size of the traditional sector:

$$Y_t = C_t + I_t + Z_{Gt} + X_t - M_t \tag{1}$$

where $Y$ is output of the modern sector, $C$ is total consumption of modern sector output, $I$ is total investment in the modern sector (and consisting of modern sector output), $Z_G$ is autonomous government spending on modern sector output, $X$ is total exports of modern output and $M$ total imports of modern sector output. The subscript $t$ indicates time. The corresponding income identity for the traditional sector would be $Y_t^T = C_t^T$, where the superscript $T$ indicates the traditional sector, but this identity plays no further role in the analysis.

Private consumption is fully endogenous, depending only on disposable income:

$$C_t = c(1 - t_t)Y_t \tag{2}$$

where $c$ is the marginal propensity to consume, and $t$ is the tax rate. Following the supermultiplier literature (Freitas & Serrano, 2015), investment is also fully endogenous, following an accelerator mechanism by which the marginal propensity to invest responds to changes in capacity utilization[1]:

$$I_t = h_t Y_t \tag{3}$$

$$\Delta h_t = \gamma(u_t - \mu) \tag{4}$$

in which $h_t$ is the marginal propensity to invest, $\mu$ is the desired long-run capacity utilization ratio, and $u$ is the capital utilization rate, which is defined as $u = \frac{Y}{Y_K}$, where $Y_K$ is full-capacity output, and $Y_K = \frac{K}{v}$, where $v$ is the normal capital-output ratio. With all this, $u = v\frac{Y}{K}$. Equations (3) and (4) act as a mechanism to take capacity utilization to the long-run level of capacity utilization $\mu$.

Capital accumulates in terms of new investments minus depreciation:

$$\Delta K_t = I_t - \delta K_t = h_t Y_t - \delta K_t \tag{5}$$

where $\delta$ is the depreciation rate.

Government spending ($Z_G$) is one component of autonomous spending, representing an important component of long-run growth in the SSM framework. It is defined as proportional to the capital stock, following an approach similar to Nomaler et al. (2021):

$$Z_{Gt} = \zeta_t K_t \tag{6}$$

in which $\zeta$ is the marginal propensity of government spending out of economy-wide wealth given by the capital stock.

Another component of autonomous spending derives from the foreign sector (exports), as in Nah & Lavoie (2017). The Southern economy is a small open economy, where the trade surplus is defined as

$$S_t = X_t - M_t \tag{7}$$

where $S$ is the trade surplus, $X$ is exports and $M$ is imports.

In line with the literature on Thirlwall's Law (Thirlwall, 1979), the tendency towards balance of payments equilibrium ($S = 0$) is taken as a the mechanism that coordinates the external sector. For simplicity, we only consider the quantity adjustment of the

[1] Throughout the analysis, we denote the forward difference by $\Delta$, and we use a hat above a variable to denote a forward growth rate, i.e., $\Delta V_t = V_{t+1} - V_t$ and $\hat{V}_t = \frac{\Delta V_t}{V_t}$ for any variable $V$.

external sector, i.e., the exchange rate is assumed to be fixed and is hence left out of the analysis entirely.

In our approach to model the balance-of-payments equilibrium, a trade surplus or deficit translates into additional (autonomous) demand (either imports or exports), such that a deficit or surplus never accumulates far away from the balance-of-payments equilibrium. We suggest that a quantity adjustment of imports is the most reasonable way in which this will happen, and this leads to the following equation for imports:

$$M_t = mY_t + S_{t-1} \tag{8}$$

in which $m$ is the marginal propensity to import out of (modern sector) income. This equation says that any trade surplus in period $t - 1$ will be fully absorbed by additional imports in period $t$. However, because imports should not become negative, this interpretation is only valid as long as

$$M_t = mY_t + S_{t-1} \geq 0 \rightarrow Y_t \geq -\frac{S_{t-1}}{m} \tag{9}$$

If $S > 0$, this holds, and even a small deficit is fine. However, if this equation does not hold, i.e., if the deficit is too large, quantity adjustment needs to take place on the exports side:

$$X_t = \bar{X}_t - S_{t-1} \tag{10}$$

where $\bar{X}_t$ stands for autonomous export demand.

It can easily be seen that these two cases (quantity adjustment on the import or export side) lead to the same income identity (equation 1). If $Y_t \geq -\frac{S_{t-1}}{m}$, then equation (8) holds (and $X_t = \bar{X}_t$), leading to

$$Y_t = c(1 - t_t)Y_t + h_tY_t + Z_{Gt} + \bar{X}_t - (mY_t + S_{t-1}) \tag{11}$$

For the case $Y_t < -\frac{S_{t-1}}{m}$, equation (10) holds (and $M_t = mY_t$), which yields

$$Y_t = c(1 - t_t)Y_t + h_tY_t + Z_{Gt} + (\bar{X}_t - S_{t-1}) - mY_t \tag{12}$$

These two equations are identical, i.e., quantity adjustment through the export side or the import side leads to the same result. However, because we consider import adjustment as a more credible mechanism (the world economy will not likely react to the behaviour of the small Southern economy), we will check our model simulations to make sure that $Y_t \geq -\frac{S_{t-1}}{m}$ holds.

We now use either equation (11) or (12) to derive modern sector output:

$$Y_t = (Z_{Gt} + \bar{X}_t - S_{t-1}) \frac{1}{1-c(1-t_t)-h_t+m} \quad (13)$$

in which the multiplier is given by $\Omega_t \equiv \frac{1}{1-c(1-t_t)-h_t+m}$.

### 3.1. The labour market and productivity

Considering a Leontief production function, labour demand in the modern sector is $\frac{Y}{a_M}$, where $a_M$ is labour productivity. Thus, the share of the labour force employed in the modern sector is given by:

$$E_{Mt} = \frac{Y_t}{a_{Mt}N_t} \quad (14)$$

where $N$ is the total labour force, which we assume grows at an exogenous rate $g_N$:

$$\Delta N_t = N_t g_N \quad (15)$$

Note that the $(1 - E_M)N$ workers not employed in the modern sector are employed in the traditional sector where they earn a subsistence wage.

Equation (14) says that the share of modern sector employment in total employment depends on output (specified by equation 13) and labour productivity. To model labour productivity in the modern sector, we follow Lavopa (2015). This means we introduce an endogenous Southern knowledge stock, as well as an exogenously growing knowledge stock in the North. The two knowledge stocks define a technology gap between the North and the South, which we specify as

$$G_t = 1 - \frac{T_{St}}{T_{Nt}} \quad (16)$$

where $G$ is the knowledge gap, and $T_S$ and $T_N$ are the knowledge stocks in the South and the North, respectively. For simplicity, we assume that foreign technological knowledge stock ($T_N$) grows at the same rate as foreign income, i.e., $\hat{T}_N = g_F$.

The knowledge stock in the Southern economy grows according to a Kaldor-Verdoorn learning mechanism and a knowledge spillover (catching-up) effect:

$$\Delta T_{St} = T_{St}\left(\tau_0 + \tau_K \hat{K}_t + \tau_G G_t\right) \quad (17)$$

where $\tau_0$ is an exogenous component of productivity growth, $\tau_K \hat{K}$ is the Kaldor-Verdoorn learning effect, and $\tau_G G$ is the knowledge spillover effect, and $\tau_K$ ('domestic learning') and $\tau_G$ ('absorptive capacity') are parameters. Next, labour productivity in the South grows depending on the growth of the knowledge stock and another learning effect represented by the share of employment in the modern sector:

$$\Delta a_{Mt} = a_{Mt}\left(\lambda_0 + \lambda_1 \hat{T}_{St} E_{Mt}\right) \tag{18}$$

where $\lambda_0$ and $\lambda_1$ are parameters.

### 3.2. Dynamics of the autonomous demand components

With the growth rates of productivity and the labour force specified, we need an equation for the growth rate of output to be able to write a dynamic equation for the share of the modern sector in employment. We observe that, in equation (13), there are three autonomous components (autonomous government spending, autonomous exports, and the trade balance from the previous period). We now consider, in turn, the growth dynamics of the three autonomous components, $\bar{X}$, $Z_G$ and $S$.

The dynamics of the autonomous part of exports $\bar{X}$ is given by the growth of the foreign economy and the income elasticity of exports (as beforementioned, we consider only quantity effects, so that the price dynamics and the real exchange rate are exogenous):

$$\Delta \bar{X}_t = \bar{X}_t \varepsilon_{Xt} g_F \tag{19}$$

where $g_F$ is the already defined growth rate of foreign income and $\varepsilon_X$ is the foreign income elasticity of imports. We model this income elasticity as a function of the technology gap between the Southern economy and the North:

$$\varepsilon_{Xt} = \varepsilon_0(1 - \varepsilon_1 G_t) \tag{20}$$

This formulation is derived from Lavopa (2015, p. 43), who argues that countries that are closer to the technological frontier (i.e., smaller $G$) tend to produce higher-quality goods, and that high-quality goods tend to have higher elasticities of demand.

As we are interested in analysing the role of a demand-led government policy to stimulate the development of the modern sector, the dynamics of $Z_G$ play a crucial role in the model. We assume that the government sets a target level (denoted by $\bar{E}$) for the employment share of the modern sector, and adjusts its spending depending on how far away the economy is from this target (this is similar to the approach in Nomaler et al, 2021). The policy instrument for this mechanism is the variable $\zeta$ (see equation 6):

$$\zeta_t = max\left[0, \zeta_{t-1} + \iota(\bar{E} - E_{M_{t-1}})\right] \tag{21}$$

where $\iota$ is a parameter that specifies the sensitivity of policy. The max(.) operator is necessary in order to avoid negative government spending that would otherwise arise if the employment share of the modern sector is above its target level.

We already specified a tax rate (the traditional sector is not taxed), thus government debt, denoted by $\Gamma$, accumulates as

$$\Delta\Gamma_t = (Z_{Gt} - t_t Y_t) \tag{22}$$

We assume that the government doesn't want debt to increase too much, and uses total wealth (defined as the capital stock $K$) as a yardstick. Thus with $D_t \equiv \Gamma_t / K_t$, government adjusts the tax rate as

$$\Delta t_t = \eta t_t D_t \tag{23}$$

Note that with the definition of $D$ and equation (22), we have

$$\Delta D_t = \frac{Z_{G_t} - t_t Y_t}{K_{t-1}} - D_t \widehat{K}_t = \zeta_t - t_t \frac{Y_t}{K_t} - D_t \widehat{K}_t \tag{24}$$

The dynamics of the trade surplus follows from equation (7):

$$\Delta S_{\mathrm{t}-1} = X_t(1 - m\Omega_{\mathrm{t}}) - S_{\mathrm{t}-1}(2 - m\Omega_{\mathrm{t}}) - \zeta_t K_t m\Omega_{\mathrm{t}} \tag{25}$$

Finally, for analytical convenience, we define a few new variables that express some of the variables in relationship to the capital stock $K$: $B_t \equiv \frac{S_{t-1}}{K_t}$ and $\chi_t \equiv \frac{X_t}{K_t}$. Applying the forward difference formula to find the change of $B$ we find

$$\Delta B_t = \frac{1}{1+\widehat{K}_t}\left(\frac{\Delta S_{t-1}}{K_t} + \widehat{K}_t \frac{S_{t-1}}{K_t}\right) \tag{26}$$

Substituting (25) into (26) yields

$$\Delta B_t = \frac{\chi_t(1-m\Omega_{\mathrm{t}}) - B_t(2-m\Omega_{\mathrm{t}}) - \zeta m\Omega_{\mathrm{t}} - B_t\hat{K}_t}{1+\hat{K}_t} \tag{27}$$

After we replace the term $\Omega_{\mathrm{t}}$ with the explicit multiplier this turns into

$$\Delta B_t = \frac{1}{1+\widehat{K}_t}\left(\frac{\chi_t(1-c(1-t_t)-h_t) - B_t[2(1-c(1-t_t)-h_t+m)-m] - \zeta_t m}{1-c(1-t_t)-h_t+m} - B_t\widehat{K}_t\right) \tag{28}$$

With the newly defined variables in terms of the stock of capital, equation (13) can be re-written as

$$Y_t = \frac{K_t(\chi_t + \zeta_t - B_t)}{1-c(1-t_t)-h_t+m} \tag{29}$$

Also, as long as $Y_t \geq -\frac{S_{t-1}}{m}$ holds, so that $X_t = \bar{X}_t$, and using equations (19) and (20), we have

$$\Delta\chi_t = \frac{\chi_t}{1+\widehat{K}_t}\left(\varepsilon_0(1-\varepsilon_1 G_t)g_F - \widehat{K}_t\right) \quad (30)$$

## 4. Steady-State Analysis

This results in the 14 equations in Box 1 that describe the entire model. In this system, eight variables ($B$, $h$, $\chi$, $\zeta$, $D$, $E_M$, $G$ and $t$) are supposed to converge to a constant level at the steady-state, while the other six ($K$, $N$, $T_S$, $T_N$, $a$, $Y$) are ever growing variables (only their growth rate converges to a constant level at the steady-state).

***Box 1. Dual Sector SSM in difference system***

$$\Delta h_t = \gamma(u_t - \mu) \quad (4)$$

$$\Delta K_t = h_t Y_t - \delta K_t \quad (5)$$

$$E_{Mt} = \frac{Y_t}{a_{Mt} N_t} \quad (14)$$

$$\Delta N_t = N_t g_N \quad (15)$$

$$G_t = 1 - \frac{T_{St}}{T_{Nt}} \quad (16)$$

$$\Delta T_{St} = T_{St}\left(\tau_0 + \tau_K \widehat{K}_t + \tau_G G_t\right) \quad (17)$$

$$\Delta a_{Mt} = a_{Mt}\left(\lambda_0 + \lambda_1 \widehat{T}_{St} E_{Mt}\right) \quad (18)$$

$$\zeta_t = max\left[0, \zeta_{t-1} + \iota(\bar{E} - E_{M_{t-1}})\right] \quad (21)$$

$$\Delta t_t = \eta t_t D_t \quad (23)$$

$$\Delta D_t = \zeta_t - t_t \frac{Y_t}{K_t} - D_t \widehat{K}_t \quad (24)$$

$$\Delta B_t = \frac{1}{1+\widehat{K}_t}\left(\frac{\chi_t(1-c(1-t_t)-h_t) - B_t[2(1-c(1-t_t)-h_t+m)-m] - \zeta_t m}{1-c(1-t_t)-h_t+m} - B_t \widehat{K}_t\right) \quad (28)$$

$$Y_t = \frac{K_t(\chi_t + \zeta_t - B_t)}{1-c(1-t_t)-h_t+m} \quad (29)$$

$$\Delta\chi_t = \frac{\chi_t}{1+\widehat{K}_t}\left(\varepsilon_0(1-\varepsilon_1 G_t)g_F - \widehat{K}_t\right) \quad (30)$$

$$\Delta T_{Nt} = T_{Nt} g_F \quad (31)$$

In the appendix, we derive the expressions for the steady states of the model. As is shown there, there are four different steady states, in the 2x2 configuration that is displayed in Table 1, which presents steady state growth rates of the Southern economy, both in absolute and in per capita terms. The two columns of the tables distinguish between the cases in which the steady-state technology gap is smaller than one (i.e., partial catch-up) or where it is equal to one (complete falling behind). This is a distinction that is mostly dependent on parameter values, i.e., depending on the parameter values, the Southern economy will either find itself in the left or the right column. However, policy (i.e., the value of $\bar{E}$) also plays a role in this, as will be shown in detail below.

The rows of the table distinguish between the cases where the Southern government does or does not implement an ambitious demand-led industrialisation policy, i.e., the parameter $\bar{E}$. With an ambitious policy, the Southern economy will find itself in the top row, without such a policy the bottom row applies.

*Table 1. Steady-state growth rates of the model*

| | $G^* < 1$ | $G^* = 1$ |
|---|---|---|
| $\bar{E}$ high | $\widehat{K}_t = \lambda_0 + \lambda_1 \bar{E} g_F + g_N$<br>$\widehat{K}_t - g_N = \lambda_0 + \lambda_1 \bar{E} g_F$ | $\widehat{K}_t = \dfrac{\lambda_0 + \lambda_1 \tau_G \bar{E} + g_N}{1 - \lambda_1 \tau_K \bar{E}}$<br>$\widehat{K}_t - g_N = \dfrac{\lambda_0 + \lambda_1 \bar{E}(\tau_G + \tau_K g_N)}{1 - \lambda_1 \tau_K \bar{E}}$ |
| $\bar{E}$ low | $\widehat{K}_t = \varepsilon_0 g_F \dfrac{(\tau_G - \varepsilon_1 g_F)}{(\tau_G - \varepsilon_0 \varepsilon_1 g_F \tau_K)}$<br>$\widehat{K}_t - g_N = \varepsilon_0 g_F \dfrac{(\tau_G - \varepsilon_1 g_F)}{(\tau_G - \varepsilon_0 \varepsilon_1 g_F \tau_K)} - g_N$ | $\widehat{K}_t = \varepsilon_0 g_F (1 - \varepsilon_1)$<br>$\widehat{K}_t - g_N = \varepsilon_0 g_F (1 - \varepsilon_1) - g_N$ |

A few things are worth noting in this table. First, the parameters $\lambda_0$ (exogenous labour productivity growth) and $\lambda_1$ (relationship between domestic knowledge stock and productivity growth) only play a role in the case that the government pursues an ambitious policy (i.e., in the top row of the table). Without such a policy, these productivity-related parameters play no role in the growth of the modern sector in the Southern economy. Instead, the parameters related to foreign income elasticity of imports, $\varepsilon_0$ (exogenous) and $\varepsilon_1$ (elasticity as related to the technology gap), along with foreign income growth $g_F$, are the main determinants of the growth rate in this case. In other words, without an ambitious demand-led government policy, Thirlwall's Law exclusively determines growth in the South, but with such a policy, productivity growth takes over this role.

Second, we see that the Kaldor-Verdoorn-like learning effect, related to the parameter $\tau_K$, plays a role in the steady-state growth rate (absolute as well as per capita) in only two of the four cases, but these cases are on a diagonal of the table rather than on a single row or in a single column. This is the case with partial catching up without ambitious policy (left-bottom cell), and with falling behind with policy (top-right cell). In both cases, a stronger learning effect (larger $\tau_K$) has a positive effect on the growth rate, but in the other cases, learning plays no role in the steady-state growth rate.

Third, we see that only when the learning parameter $\tau_K$ plays a role in the growth rate does the technology gap-spillover effect related to parameter $\tau_G$ also play a role. In both cases, the effect is positive, i.e., stronger spillovers will increase the growth rate. This suggests that a supply-side industrialisation policy should be aimed jointly at domestic learning ($\tau_K$) and at absorptive capacity for assimilating knowledge from abroad ($\tau_G$).

Fourth, we see that population growth (the parameter $g_N$) plays a very different role between the four cells of the table in per capita growth. It plays no role if the South partially catches up, and the demand-led policy is ambitious (top left). Per capita growth is affected negatively by population growth if government demand-led policy is unambitious (bottom row of the table, both cells), and there is a positive effect of population growth with falling behind and ambitious demand-led policy (top right).

### 4.1. Simulation 1: the effectiveness of a demand-led industrialisation policy

We now proceed to illustrate the effect of a demand-led industrialisation policy by means of some simulations of the model. We use the following parameter values in the first simulation: $c = 0.7, \delta = 0.05, \mu = 0.75, \upsilon = 2.7, \gamma = 0.003, \tau_0 = 0, \tau_K = 0.35, \tau_G = 0.06$, $g_F = 0.04, m = 0.2, \varepsilon_0 = 0.25, \varepsilon_1 = 0.4, g_N = 0, \iota = 0.05, \eta = 0.075, \lambda_0 = 0, \lambda_1 = 1$. At the start of the simulation, $\bar{E}$ is set to zero, but after 1250 periods, the demand-led policy is implemented by setting $\bar{E} = 0.9$. These parameter values imply that at the start of the simulation, the steady state value of the technology gap is $< 1$ (this can be seen in equation 35 in the Appendix), and with $\bar{E} = 0$ the policy ambition is low, hence we are in the bottom left part of Table 1.

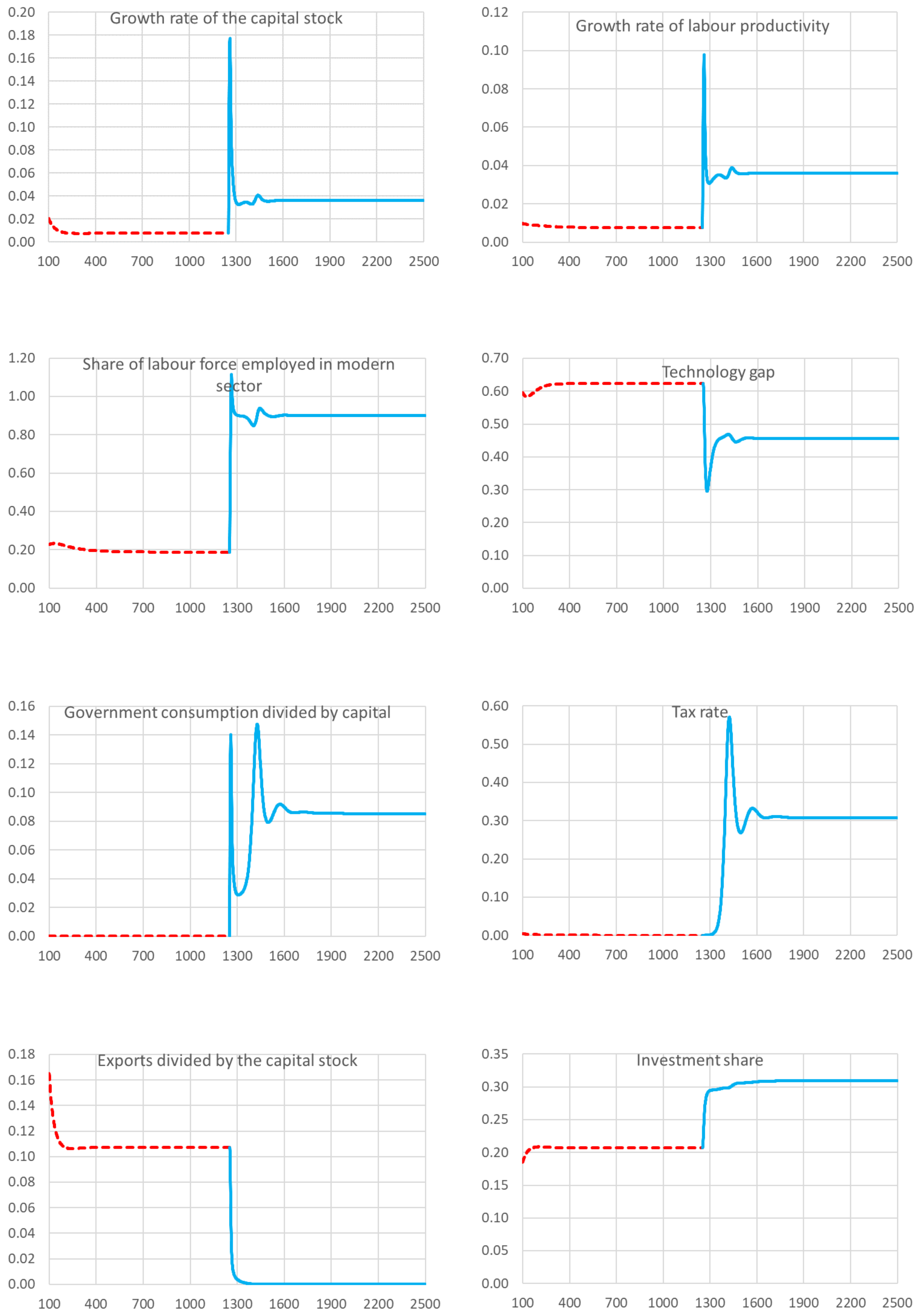


*Figure 1. Simulation 1: results for eight selected variables*

Figure 1 shows the simulation results, with the dashed line corresponding to the period before the implementation of the demand-led policy and the solid line corresponding to the period with the policy. The first 100 periods, which show adjustment from the initial conditions to the steady-state without policy, are omitted from the figure. We see that, without the policy, the economy settles down to a steady-state with a positive but low growth rate, and with a share of the labour force employed in the modern sector that is $\approx 0.188$ (this is the value given by Equation 39 in the Appendix). The technology gap converges to a value $\approx 0.623 < 1$, as referenced above. The investment share converges to its steady-state, and so do exports divided by the capital stock. The policy parameters $\zeta$ and $t$ both converge to zero, because the demand-led policy is absent ($\bar{E} = 0$).

When the policy is implemented at period 1250, we see a relatively quick adjustment to the new steady-state. The share of the labour force in the modern sector adjusts to the new value $\bar{E} = 0.9$. The growth rate (of capital and labour productivity) adjusts upward to a value $\approx 0.036$. Note that, although the Southern economy catches up partially in terms of the knowledge gap, which is constant in the steady-state, its modern sector still grows somewhat slower than the Northern economy (3.6% vs. 4%). The investment share is also adjusted upward so that it can keep pace with the higher growth rate of the capital stock.

Exports as a fraction of capital converge to zero. This is predicted by the steady-state analysis in the Appendix, which shows that with the ambitious demand-led policy in place, the Southern economy becomes government demand-led instead of export-led. As a result of the ambitious government policy, the policy parameters $\zeta$ and $t$ both converge to positive values, which for the tax rate $t$ is about 30%. Given the ambitious goal of a demand-led industrialization policy combined with a balanced government budget, this seems a reasonable value. Thus, the simulation clearly shows how a demand-led industrialisation policy may be successful in this model.

As was noted above, even if the Southern economy catches up partially to the technological frontier of the North, it does not catch up in terms of growth, which is 0.04 in the North, and 0.036 in the South. The expressions for the Southern growth rate in the left column of Table 1 contain the growth rate of the North, $g_F$, hence we can derive a condition under which the steady-state growth rate of the South will be higher than the Northern growth rate. For the case $G^* < 1$ and sufficiently high $\bar{E}$, we can write

$$\widehat{K}_t = \lambda_0 + \lambda_1 \bar{E} g_F + g_N > g_F \rightarrow$$

$$if\ \lambda_1 \bar{E} < 1, then\ \frac{\lambda_0 + g_N}{1 - \lambda_1 \bar{E}} > g_F$$

$$if\ \lambda_1 \bar{E} > 1, then\ \frac{\lambda_0 + g_N}{1 - \lambda_1 \bar{E}} < g_F$$

This shows that the most interesting parameter to achieve higher-than-North growth is $\lambda_1$, the parameter that translates knowledge stock growth to productivity growth. Setting $\bar{E} = 1$ (the most ambitious policy possible), and with simulation settings $\lambda_0 = g_N = 0$, only $\lambda_1 = 1$ would be enough to achieve a growth rate equal to that in the North. $\lambda_1 > 1$ would achieve a higher growth rate, but it is hard to think why or how productivity could grow faster than knowledge in the steady-state. Industrial policy to stimulate knowledge diffusion could achieve this temporarily, but in terms of long-run growth, $\lambda_1 = 1$, which suggests complete diffusion of knowledge, seems the most optimistic but still a reasonable assumption. Hence we conclude that catching up in terms of the Southern knowledge stock may at best lead to an equal growth rate between the South and the North.

### 4.2. Simulation 2: industrialisation policy with falling behind

In the next simulation, we start from a parameter set that implies falling behind. We use the same parameter set as in the previous simulation, with one exception: we set $\tau_G = 0.03$ and $\tau_K = 0.02$. We also use the same setup with $\bar{E} = 0$ initially, and a policy change to $\bar{E} = 0.9$ at period 1250. These parameter values imply $G^* = 1$ (the right-hand side of Appendix equation 35 $\approx 1.301$), and hence we are in the bottom right part of Table 1 (falling behind).

As in the previous simulation, the Southern economy converges to a steady-state without policy, and then, under the influence of the policy, converges to a higher growth path (the growth rate $\approx 0.033$). As before, the policy transition implies that exports divided by the capital stock come down from a positive value to zero, and that the two policy variables converge from zero to a positive value. The technology gap converges slowly to its steady-state value of 1 without the policy, and then stays there even with the policy.

The conclusion is that, in the falling-behind case, the basic working of the demand-led industrialisation policy is the same as in the case of partial catching up. The steady-state growth rates and other variables are determined in different ways (see Table 1), but demand-led policy is an effective tool for industrialisation in both cases.

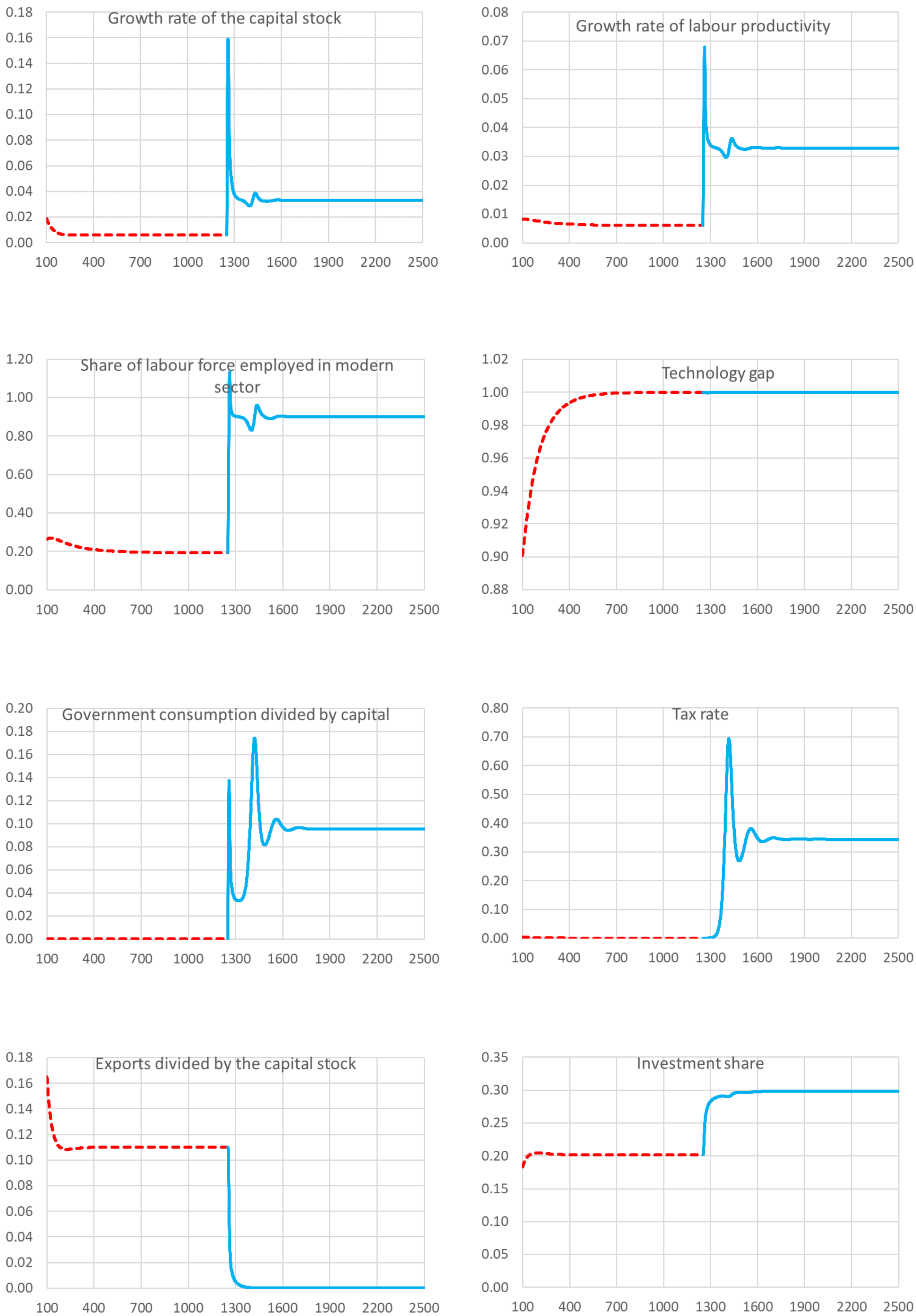


*Figure 2. Simulation 2: results for eight selected variables*

### 4.3. Simulation 3: industrialisation policy to move from falling behind to partial catching up

The final simulation is concerned with a rare case (in terms of parameter values), which is to use demand-led industrialization policy to move the economy from a state of falling behind to one of partial catching up. In terms of Table 1, this means that we move from the lower-right cell to the upper-left cell. We use parameter values equal to the first simulation (so $\tau_K = 0.35$), except $\tau_G = 0.035$. Figure 3 shows the simulation results for this case (again, we change $\bar{E}$ from zero to 0.9 at period 1250).

To see how this works, we must look at the different steady states that are calculated in the Appendix. The condition for falling behind without ambitious policy ($G^* = 1$ and $\bar{E} = 0$) can be formulated as[2]

$$g_F\left(\frac{1-\varepsilon_0\tau_K}{(\tau_G-\varepsilon_0\varepsilon_1 g_F\tau_K)}\right) > 1 \rightarrow$$

$$if\ \tau_G - \varepsilon_0\varepsilon_1 g_F \tau_K > 0\ then\ 1 - \varepsilon_0\tau_K(1-\varepsilon_1) > \frac{\tau_G}{g_F}$$

$$if\ \tau_G - \varepsilon_0\varepsilon_1 g_F \tau_K < 0\ then\ 1 - \varepsilon_0\tau_K(1-\varepsilon_1) < \frac{\tau_G}{g_F} \qquad (63)$$

Note that, in the expression on the right-hand side of this, the absorptive capacity parameter $\tau_G$ plays a main role. This is the parameter that links the technology gap to spillovers received by the South, and hence we would expect that the parameter would also play a large role in a supply side-oriented industrialisation policy.

With the parameter values used in our simulation, $\tau_G - \varepsilon_0\varepsilon_1 g_F \tau_K > 0$ and also $1 - \varepsilon_0\tau_K(1-\varepsilon_1) > \frac{\tau_G}{g_F}$, hence we expect falling behind in the first part of the simulation (i.e., without a demand-led policy). As Figure 3 shows, this is indeed the case, i.e., the technology gap converges to one.

For catching up to occur with the demand-led policy, we can derive the following condition[3]

$$\frac{g_F(1-\tau_K\lambda_1\bar{E}) - \tau_K(\lambda_0 + g_N)}{\tau_G} < 1 \rightarrow$$

[2] Falling behind is the case where the right-hand side of Appendix equation (35) is larger than one, but we must first substitute Appendix equation (37), which gives an expression for $E_M^*$ in case of no policy, into (35) and solve to get parameter values that yield values for equation (35) that are larger than one.
[3] We must substitute $E_M^* = \bar{E}$ into equation (35) and solve for that equation to be smaller than one.

$$1 - \tau_K \left( \lambda_1 \bar{E} + \frac{\lambda_0 + g_N}{g_F} \right) < \frac{\tau_G}{g_F}$$

Combining the two conditions (falling behind without the policy and catching up with the policy), we get

$$1 - \tau_K \left( \lambda_1 \bar{E} + \frac{\lambda_0 + g_N}{g_F} \right) < \frac{\tau_G}{g_F} < 1 - \varepsilon_0 \tau_K (1 - \varepsilon_1)$$

Which, with our chosen parameter values, translates to

$$0.685 < 0.875 < 0.948$$

Thus, with the parameter values chosen for this simulation run, we should indeed see catching up with the demand-led policy implemented. Note, however, that this is a relatively rare case. For example, if we substitute all parameter values except $\tau_G$, we get

$$0.0274 < \tau_G < 0.0379$$

as the condition for the demand-led policy to be able to move the Southern economy from falling behind to partial catching up (ceteris paribus all parameter values except $\tau_G$), which is a rather narrow range for the catching-up parameter.

Given that the conditions are satisfied with our parameter values, we look at Figure 3 and see that the technology gap indeed decreases from 1 to a lower value after the policy is implemented. Growth rates of the capital stock and productivity, as well as the investment share, increase with the implementation of the policy, as before (the after-policy growth rate $\approx 0.036$).

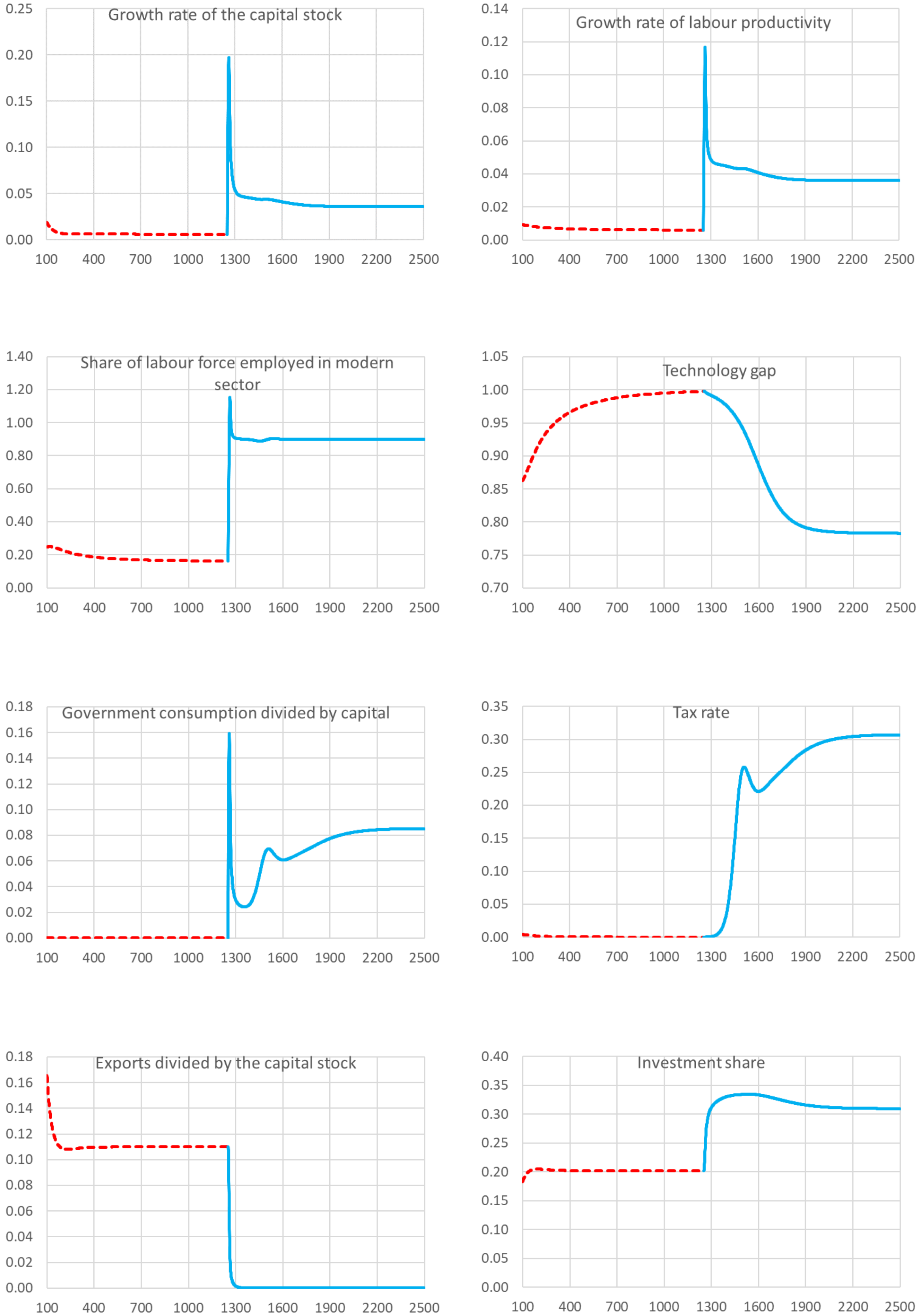


*Figure 3. Simulation 3: results for eight selected variables*

## 5. Discussion

Our model draws on three types of stability mechanisms for the Southern economy: (1) stability in the productive system in terms of capacity utilisation, (2) stability in the labour market in terms of the employment rate in the modern sector, and (3) stability of the external sector in terms of the trade balance.

The stability of capital utilisation is defined by the original SSM (Freitas & Serrano, 2015). Firms have a desired level of capacity utilisation, and they adjust their investment decision (marginal propensity to invest) in order to lead the actual level of capacity utilisation of the economy to its desired level. For stability in terms of employment, we draw on the approach of Nomaler et al. (2021). Government policy implements a consumption-smoothing mechanism that answers to changes in effective employment from the target employment rate. In this dual-sector version, the employment target considers the share of employment in the modern sector. In terms of the external sector, we draw on the balance of payments constrained model (BPCM), and explicitly models the import and export functions of the Southern economy. We consider the presence of (only) quantity adjustments. Following Nah and Lavoie (2017), the import function is induced by domestic output and, as in Thirlwall (1979), the export function depends on foreign output and on the income elasticity of exports. The latter element is defined by the structural conditions of the economy (Lavopa, 2015; Porcile & Spinola, 2018), given by technology-accumulated knowledge.

The model that was presented above has multiple equilibria (steady-states). Which of the steady-states will be attained depends, on the one hand, on supply-side conditions, and on the other hand on a government demand-led policy. The supply-side conditions will determine whether or not the Southern economy will attain partial catching up to the technological frontier in the absence of a sufficiently ambitious demand-led policy (equation 63). By increasing domestic learning capacity and/or the capacity to assimilate foreign knowledge, a supply-side government policy can bring the Southern economy into a state where partial catching up is possible. The spontaneous development of the modern sector is the mechanism by which catching-up takes place.

However, without a demand-led government policy by which the government consumes output from the modern sector, the development of the modern sector will hold at a relatively low level in which only a (small) fraction of the total labour force is employed in the modern sector. Irrespective of whether or not the Southern economy catches up (partially), a sufficiently ambitious demand-led industrialisation policy will raise the share of the modern sector in total employment, as well as the (per capita) growth rate.

Without a demand-led industrialisation policy, growth in the South will be determined by foreign income elasticities of imports and the foreign growth rate. In other words, in this case, the domestic Southern economy is export led and subject to Thirlwall's law, by which the relative growth rate of the South (compared to the leading North) depends on income elasticities. If the government implements an ambitious demand-led policy, the economy becomes government demand led, and supply-side parameters (as discussed before) determine the growth rate. Government demand can also initiate the partial catching up of the Southern economy, but this seems a rather rare case associated with a narrow parameter range.

## 7. Conclusion

In our theoretical model, government consumption demand can be an important component of industrialisation policy. Although the economy that we model can develop a modern sector without notable government consumption, industrialisation can be further enhanced by a demand-led policy, even with a balanced government budget. We derived multiple steady states that illustrate this point, and also showed several simulations that support the conclusions of the steady-state analysis.

However, our approach has been exclusively theoretical. Although we draw on several mechanisms that are well-documented in the literature, such as learning and technology spillovers, we have so far been unable to provide any empirical interpretation of the main parameters of our model. Thus, it remains hard to judge to what extent a demand-led industrialisation policy adds additional growth to supply-side policy. Knowing more about reasonable parameter value ranges will enable us to gain insight, for example, into how far industrialisation can go without government consumption demand, or whether government consumption is necessary to push economies out of the middle-income trap.

We feel that this is a gap in the literature, which has focused mainly on supply-side policies for industrialisation. Although we do not want to detract from the importance of supply-side policy, we also feel that more empirical research on the potential role of a demand-led industrialisation policy will be useful. One avenue along which this would be possible would be to provide a calibration of the parameters of the model that we proposed, as well as the collection of (historical) empirical data on the role of government consumption in industrialising economies.

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## Appendix. Derivation of the steady states

We start the search for a steady-state growth path of the Southern economy by looking at the behaviour of the technology gap. From equation (16), it is clear that any steady-state where $G < 1$ requires $\hat{T}_S = \hat{T}_N = g_F$. Setting $\tau_0 = 0$ for mathematical convenience, and using equations (17) and (31), we can formulate this requirement as follows:

$$\hat{T}_{S_t} = \tau_K \hat{K}_t + \tau_G G_t = g_F \quad (32)$$

We can find an expression for labour productivity growth in the modern sector by substituting (32) into equation (18):

$$\hat{a}_{Mt} = \lambda_0 + \lambda_1 g_F E_{Mt} \quad (33)$$

This shows that for $\hat{a}_M$ to converge to a steady-state value, $E_M = \frac{K}{a_M N}$ needs to converge to a constant, which, in turn, implies $\hat{a}_M + \hat{N} = \hat{K}$:

$$\lambda_0 + \lambda_1 g_F E_{Mt} + g_N = \hat{K}_t \quad (34)$$

Substituting this into equation (32) yields

$$G_t = \frac{g_F(1-\tau_K\lambda_1 E_{Mt}) - \tau_K(\lambda_0 + g_N)}{\tau_G} \quad (35)$$

This gives a steady-state value for the technology gap as a function of parameters, as well as the endogenous variable $E_M$. To find out about the steady-state value of this variable, we look at equation (30), which specifies the dynamics of exports (as a fraction of the capital stock), $\chi$. Equation (30) shows that there are two potential steady values for $\chi$. One is $\chi^* = 0$, and the other stems from setting $\varepsilon_0(1-\varepsilon_1 G_t)g_F - \hat{K}_t$ to zero. Although the steady-state value $\chi^* = 0$ may appear as trivial, it turns out that it is not. However, we start by investigating the other option, i.e., setting $\varepsilon_0(1-\varepsilon_1 G_t)g_F = \hat{K}_t$. Using equations (34) and (35), this implies

$$\varepsilon_0\left(1 - \varepsilon_1 \frac{g_F(1-\tau_K\lambda_1 E_{Mt}) - \tau_K(\lambda_0 + g_N)}{\tau_G}\right) g_F = \lambda_0 + \lambda_1 g_F E_{Mt} + g_N \quad (36)$$

which solves for

$$E_{Mt} = \frac{\varepsilon_0 g_F(\tau_G - \varepsilon_1 g_F) + (\lambda_0 + g_N)(\varepsilon_0\varepsilon_1\tau_K g_F - \tau_G)}{\lambda_1 g_F(\tau_G - \varepsilon_0\varepsilon_1 g_F \tau_K)} \quad (37)$$

Equations (35) and (37) are key to understanding the dynamic behaviour of the model, and the role of government policy in stimulating the development of the modern sector. Substituting (37) into (35) gives an expression for the steady-state value of the technology gap, $G^*$. There are two possibilities that require separate analysis. The first is that $0 < G^* < 1$, and the second is $G^* > 1$.

The latter of these cases makes little economic sense, because, according to equation (16), it requires that the division $\frac{T_{St}}{T_{Nt}} < 0$, suggesting that exactly one of the two technology stocks would be negative. However, if the initial technology gap obeys $0 < G < 1$, then if in equation (35) $G^* > 1$, and if change is gradual (i.e., in relatively small steps), convergence will not be to the value $G^* > 1$, but instead to $G^* = 1$. To see this, note that the dynamic version of equation (16) is

$$\Delta G_t = -\frac{T_{St}}{T_{Nt}}\left(\hat{T}_{St} - \hat{T}_{Nt}\right) = (G - 1)\left(\hat{T}_{St} - \hat{T}_{Nt}\right) \tag{38}$$

The first term on the righthand side implies that if $G \to 1$, $\Delta G_t \to 0$, implying that $G^* = 1$ is also a steady-state value. The steady-state value $G^* = 1$ arises in case $G^* > 1$ in equation (35). Note that $G^* = 1$ represents a case where the Southern country falls behind relative to the North in terms of the knowledge stock, whereas $G^* > 1$ represents partial catching up (the smaller $G^*$, the higher the degree of steady-state catching up).

A further complication in the steady-state analysis arises from government policy. To see this, note that the steady-state value $E_M^*$ that is implied by equation (36) will only by chance be equal to $\bar{E}$, the government policy target for the employment share of the modern sector. At the same time, equation (21) suggests that $E_M^* = \bar{E}$ is a steady-state value for the modern sector employment share.

The interesting case is where $\bar{E}$ is larger than the steady state value $E_M^*$ suggested by equation (36):

$$\bar{E} > \frac{\varepsilon_0 g_F(\tau_G - \varepsilon_1 g_F) + (\varepsilon_0 \varepsilon_1 \tau_K g_F - \tau_G)(\lambda_0 + g_N)}{\lambda_1 g_F(\tau_G - \varepsilon_0 \varepsilon_1 \tau_K g_F)} \tag{39}$$

This is when government policy is ambitious, i.e., the government wants to raise the employment share of the modern sector above the steady-state level without policy intervention. To see how this influences the analysis, we look again at equation (30), the dynamic equation for exports, noting as before that one steady-state value arises if $\varepsilon_0(1 - \varepsilon_1 G_t) g_F = \hat{K}_t$. Substituting (34) and (35) yields equation (36) as before, but now $E_{Mt} = \bar{E}$ would have to be substituted instead of solving the equation for $E_M$.

Equation (34) shows that $E_{Mt} = \bar{E}$ with $\bar{E}$ larger than the steady-state value of equation (37) yields a higher rate of growth of the capital stock, compared to when equation (37) holds. This means that the term $\varepsilon_0(1 - \varepsilon_1 G_t) g_F - \hat{K}_t$ in equation (30) will become negative, implying a falling value of $\chi$. This is where the other steady-state value for $\chi$, i.e., $\chi^* = 0$ comes back into the picture. A constantly falling $\chi$ will converge to this steady-state value.

The steady-state value $\chi^* = 0$ suggests that, under ambitious development intervention, exports are relatively unimportant for the Southern economy, even though the trade surplus (variable B) plays a substantial role in the growth process. Instead of an export-led economy, the South has become a government demand-led economy. To show how this works, in particular what the steady-state values of some of the other variables are, we now proceed to analyse the two cases for the steady-state technology gap, $G^* < 1$ and $G^* = 1$ separately.

*4.1. The case in which $G^* < 1$*

We start the analysis of this case by considering the sub-case where equation (39) holds, i.e., where the government pursues an active policy to stimulate the development of the modern sector. We start by looking for a steady-state value for B (the trade balance as a fraction of the capital stock). This requires that equation (28) is zero. This means

$$\chi_t(1 - c(1 - t_t) - h_t) - \zeta_t m = B_t\left(\left(\widehat{K}_t + 2\right)(1 - c(1 - t_t) - h_t + m) - m\right) \quad (40)$$

Because we already established that when (39) holds, the steady-state value for $\chi$ is $\chi^* = 0$, this equation can be simplified to yield

$$B_t = \frac{-\zeta_t m}{(\widehat{K}_t + 2)(1 - c(1 - t_t) - h_t + m) - m} \quad (41)$$

We now move to equation (4), and first substitute the definition $u = v\frac{Y}{K}$, and then equation (29), to obtain

$$\Delta h_t = \gamma\left(v\frac{(\chi_t + \zeta_t - B_t)}{1 - c(1 - t_t) - h_t + m} - \mu\right) = 0 \rightarrow \frac{(\zeta_t - B_t)}{1 - c(1 - t_t) - h_t + m} = \frac{\mu}{v} \quad (42)$$

Substituting $E_{Mt} = \bar{E}$ in equation (34) yields

$$\widehat{K}_t = \lambda_0 + \lambda_1 \bar{E} g_F + g_N \quad (43)$$

We can then slightly re-write equation (5), substitute (29) and substitute (42) to obtain

$$\widehat{K}_t = h_t\frac{Y_t}{K_t} - \delta \rightarrow h^* = \frac{(\lambda_0 + \lambda_1 g_F \bar{E} + g_N + \delta)v}{\mu} \quad (44)$$

For a steady-state value of the tax rate to exist, equation (23) requires $D^* = 0$. Thus, we can set equation (24) to zero, substitute (29), (34), (41), (43) as well as $D^* = 0$, $E_M = \bar{E}$ and $\chi^* = 0$ to obtain the steady-state value for the tax rate:

$$t^* = 1 - \frac{1}{1-c}\left(\frac{v(\lambda_0+\lambda_1\bar{E}g_F+g_N+\delta)}{\mu} + m\frac{1+\lambda_0+\lambda_1\bar{E}g_F+g_N}{2+\lambda_0+\lambda_1\bar{E}g_F+g_N}\right) \quad (45)$$

To obtain the steady-state value for $\zeta$, we first set equation (24) to zero, which yields $\zeta_t = t_t\frac{Y_t}{K_t}$. Then we also set equation (4)to zero, which implies $u_t = v\frac{Y_t}{K_t} = \mu \rightarrow \frac{v}{\mu} = \frac{K_t}{Y_t}$. Finally, with these two results, equation (45) implies:

$$\zeta^* = \frac{\mu}{v}\left(1 - \frac{1}{1-c}\left(\frac{v(\lambda_0+\lambda_1\bar{E}g_F+g_N+\delta)}{\mu} + m\frac{1+\lambda_0+\lambda_1\bar{E}g_F+g_N}{2+\lambda_0+\lambda_1\bar{E}g_F+g_N}\right)\right) \quad (46)$$

So far, we assumed that the government implements an ambitious industrialisation policy, i.e., $\bar{E}$ is set to a value that is larger than the value defined by equation (37). We now proceed to analyze the case where this is not the case, i.e., $\bar{E}$ is lower than the value of equation (37), including the possibility of having no policy at all (i.e., $\bar{E} = 0$).

In this case, the steady-state value of $E_M$ is given by equation (37), i.e.,

$$E_M^* = \frac{\varepsilon_0 g_F(\tau_G-\varepsilon_1 g_F)+(\lambda_0+g_N)(\varepsilon_0\varepsilon_1\tau_K g_F-\tau_G)}{\lambda_1 g_F(\tau_G-\varepsilon_0\varepsilon_1 g_F\tau_K)} \quad (47)$$

We must substitute this into equation (34) to obtain the growth rate of the capital stock for this case:

$$\widehat{K}_t = \varepsilon_0 g_F\frac{(\tau_G-\varepsilon_1 g_F)}{(\tau_G-\varepsilon_0\varepsilon_1 g_F\tau_K)} \quad (48)$$

In this steady-state, because $\bar{E} - E_M^* < 0$, the max operator in equation (21) takes effect, which implies $\zeta^* = 0$. This, in turn, through equation (24) implies $t^* = 0$. We then proceed, as before, to set equation (28) to zero, but this time substituting $\zeta = 0$, and obtain

$$B_t = \frac{\chi_t(1-c(1-t_t)-h_t)}{(2+\widehat{K}_t)(1-c(1-t_t)-h_t+m)-m} \quad (49)$$

Equation (49) is the alternative to (41), which is only valid with an active and ambitious government policy. We can now proceed in exactly the same way as in the case with $\bar{E} > E_M^*$, but with $\zeta = 0$. First we obtain

$$\Delta h_t = \gamma\left(v\frac{(\chi_t-B_t)}{1-c(1-t_t)-h_t+m} - \mu\right) = 0 \rightarrow \chi_t = B_t + \frac{\mu}{v}(1-c(1-t_t)-h_t+m) \quad (50)$$

This can be substituted into equation (49) along with $t = 0$ to yield

$$B_t = \frac{\mu}{v}\frac{(1-c-h_t)}{\widehat{K}_t+1}$$

The equivalent of equation (44) then becomes

$$h^* = \left(\lambda_0 + g_N + \delta + \frac{\varepsilon_0 g_F(\tau_G - \varepsilon_1 g_F) + (\lambda_0 + g_N)(\varepsilon_0 \varepsilon_1 \tau_K g_F - \tau_G)}{(\tau_G - \varepsilon_0 \varepsilon_1 g_F \tau_K)}\right)\frac{\upsilon}{\mu} \qquad (51)$$

*4.2. The case in which $G^* = 1$*

The case $G^* < 1$ that has been analysed so far is based on the assumption that the right-hand side of equation (35) is smaller than one. However, as already discussed, this may not be true, i.e., the right-hand side of (35) may be larger than one, and in this case the technology gap will converge to a steady-state value of one. $G^* = 1$ implies that the Southern economy falls behind relative to the North. However, the Southern government may still implement a policy to stimulate the modern sector.

With $G^* = 1$, we need to derive an alternative sequence of equations (32) – (39). The knowledge stock in the South now grows according to

$$\hat{T}_{St} = \tau_K \hat{K}_t + \tau_G \qquad (52)$$

and the growth rate of labour productivity becomes

$$\hat{a}_{Mt} = \lambda_0 + \lambda_1(\tau_K \hat{K}_t + \tau_G)E_{Mt} \qquad (53)$$

A steady-state for $E_M$ still requires $\hat{a}_{Mt} + g_N = \hat{K}_t$ (equation 14), which leads to

$$\lambda_0 + \lambda_1(\tau_K \hat{K}_t + \tau_G)E_{Mt} + g_N = \hat{K}_t \rightarrow \hat{K}_t = \frac{\lambda_0 + \lambda_1 \tau_G E_{Mt} + g_N}{1 - \lambda_1 \tau_K E_{Mt}} \qquad (54)$$

Now we set equation (30) to zero again, using equation (54) as well as $G = 1$. As before, we start by considering the steady-state where $\chi$ is not equal to zero, which yields

$$\varepsilon_0(1 - \varepsilon_1 G_t)g_F = \frac{\lambda_0 + \lambda_1 \tau_G E_{Mt} + g_N}{1 - \lambda_1 \tau_K E_{Mt}} \rightarrow E_{Mt} = \frac{\varepsilon_0(1-\varepsilon_1)g_F - (\lambda_0 + g_N)}{\lambda_1(\tau_G + \varepsilon_0 g_F \tau_K(1-\varepsilon_1))} \qquad (55)$$

The associated condition for an ambitious industrialisation policy is then

$$\bar{E} > \frac{\varepsilon_0(1-\varepsilon_1)g_F - (\lambda_0 + g_N)}{\lambda_1(\tau_G + \varepsilon_0 g_F \tau_K(1-\varepsilon_1))} \qquad (56)$$

As before, if the condition in equation (56) holds, then $E_M^* = \bar{E}$, $\chi^* = 0$, $\zeta^* > 0$ and $t^* > 0$. If the condition does not hold, then equation (55) gives $E_M^*$, $\chi^* > 0$, $\zeta^* = 0$ and $t^* = 0$. In deriving the steady-states for the falling behind case, we first consider the case where the condition holds, i.e., the government undertakes an ambitious industrialisation policy.

We can proceed as before, i.e., equate equations (5) and (54), substitute $E_M = \bar{E}$ as well as $\frac{Y_t}{K_t} = \frac{\mu}{v}$ to obtain the steady-state value for the investment rate:

$$\hat{K}_t = h_t \frac{Y_t}{K_t} - \delta = \frac{\lambda_0 + \lambda_1 \tau_G \bar{E} + g_N}{1 - \lambda_1 \tau_K \bar{E}} \rightarrow h^* = \left(\frac{\lambda_0 + \lambda_1 \tau_G \bar{E} + g_N}{1 - \lambda_1 \tau_K \bar{E}} + \delta\right) \frac{v}{\mu} \tag{57}$$

Proceeding as we did to obtain equation (45), we now get

$$t^* = 1 - \left(\frac{\lambda_0 + \lambda_1 \tau_G \bar{E} + g_N}{1 - \lambda_1 \tau_K \bar{E}} + \delta\right) \frac{v}{\mu(1-c)} + \frac{m}{1-c} \left(\frac{1 + \lambda_1 \bar{E}(\tau_G - \tau_K) + \lambda_0 + g_N}{2 + \lambda_1 \bar{E}(\tau_G - 2\tau_K) + \lambda_0 + g_N}\right) \tag{58}$$

and

$$\zeta^* = \frac{\mu}{v} \left(1 - \left(\frac{\lambda_0 + \lambda_1 \tau_G \bar{E} + g_N}{1 - \lambda_1 \tau_K \bar{E}} + \delta\right) \frac{v}{\mu(1-c)} + \frac{m}{1-c} \left(\frac{1 + \lambda_1 \bar{E}(\tau_G - \tau_K) + \lambda_0 + g_N}{2 + \lambda_1 \bar{E}(\tau_G - 2\tau_K) + \lambda_0 + g_N}\right)\right) \tag{59}$$

Finally, we need to look at the case where $G^* = 1$ and condition (56) does not hold. Using the same reasoning as in the case $G^* < 1$, we have $\zeta^* = 0$ and $t^* = 0$, while

$$E_M^* = \frac{\varepsilon_0(1-\varepsilon_1) g_F - (\lambda_0 + g_N)}{\lambda_1(\tau_G + \varepsilon_0 g_F \tau_K (1-\varepsilon_1))} \tag{60}$$

The growth rate of the capital stock then becomes

$$\hat{K}_t = \varepsilon_0 g_F (1 - \varepsilon_1) \tag{61}$$

Equations (49) and (50) still hold, and thus we may readily derive the following as an alternative to equation (51):

$$h^* = (\varepsilon_0 g_F (1 - \varepsilon_1) + \delta) \frac{v}{\mu} \tag{62}$$