Heterodox macroeconomic model for the Greek economy.

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Με τη χρηματοδότηση της Ευρωπαϊκής Ένωσης
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Economic models for Greece in historical perspective: A survey of the postwar developments

Abstract

This paper offers a comprehensive historical survey of economic modeling practices in Greece, focusing on the postwar era through the lens of theoretical, methodological, and policy-driven transformations. The study emphasizes that economic modeling in Greece has evolved in tandem with broader shifts in economic thought, European integration, and domestic policy needs.

The early postwar period (1950s–1970s) saw the emergence of developmentalist and Keynesian-inspired models aimed at addressing reconstruction, industrialization, and foreign aid utilization. These models were simple, macroeconomic frameworks reflecting the dominant belief in state-led growth and investment planning. As the process of integration between European institutions and Greece was deepening, particularly with the advent of EU cohesion funding mechanisms like the Delors Packages, economic modeling became more sophisticated. This shift was marked by the adoption of large-scale, econometric, and eventually dynamic stochastic general equilibrium (DSGE) models that mirrored developments in mainstream New Keynesian economics.

The paper distinguishes between two broad modeling eras: the Reconstruction era characterized by rudimentary, planning-oriented models, and the post-1970s period, which saw a transition to complex econometric frameworks driven by democratization, modernization, and policy conditionalities tied to EU integration. Theoretical debates – from classical political economy and Keynesianism to the rise of monetarism, rational expectations, and real business cycle theories – shaped the technical features and assumptions of these models.

A critical component of the analysis involves examining the interface between planning doctrines, the role of international financial institutions (notably the IMF), and the domestic response to macroeconomic challenges such as inflation, unemployment, and trade deficits. The document also evaluates models such as Harrod-Domar, Feldman, IS-LM, Solow, and various IMF frameworks like the Polak model, illustrating how these were adapted to the Greek context over time.

Ultimately, the paper situates Greek economic modeling within a broader narrative of intellectual convergence and divergence, showing how domestic needs, theoretical advancements, and international political economy jointly sculpted Greece's modeling traditions. It concludes that economic models were not only technical tools but also ideological artifacts reflecting evolving paradigms of growth, stability, and European economic governance.

1. Introduction

The history of economic modelling for policy and forecasting of the Greek economy may be characterized as relatively brief and by no means, extensive. A close examination and systematic review of the existing literature highlights the scarcity of relevant efforts, both from individual researchers, academic scholarships, and institutions alike.[1] Hence, to fill this gap, the purpose of what follows below is to shed some light on the majority of the economic models that have been proposed over the years, elucidating some methodological and theoretical foundations upon which they were developed.

Beginning in the early 1960s, three Keynesian-type models emerged, focusing on the demand side of the Greek economy. These models do follow the trend of their time, they belong to the *developmentalist* tradition and represent the earliest endeavors to apply some algebraic and econometric methods available. However, as the years pass by and the statistical databases become more detailed and available to the public, the techniques change and shift to more complex structures of dynamic stochastic general equilibrium models of New Keynesian type.[2]

Most importantly, their characteristic transformations in method and technique seem to be directed by the immediate requirements, aims, and policy challenges dictated by the European institutions, especially as Greece was gradually integrated as a full member of the Single Market. The early post-war models were seeking to evaluate the efficiency of the foreign aid provided to Greece by the US, whereas later on, the financial aid was needed to increase the allocation of other European resources such as the *Integrated Mediterranean Programmes* established in 1983, or the *Community Support Frameworks* that succeeded them, also known to the public as "Delor's Packages".

On top of these developments, the methodological changes of the economic models have been deeply intertwined with the evolution of mainstream economic thought. Theoretical debates, academic discourses, and political arguments have significantly shaped the dominant practices of model-building over the decades, particularly during the post-war era. The rise and fall of Keynesian economics (Angelis, 2000; Eatwell &

[1] Some notable exceptions are Ψαλιδόπουλος (2016) and Petrakis and Kostis (2014).

[2] Stockhammer (2013) underlines that: "[The] NK-DSGE models are mainstream in economic policy (e.g. the IMF or the Central Banks use them). However, the mainstream in academic research is more in line with New Classical economics, i.e. stronger in the tradition of General Equilibrium models. These models are quite different from neo-liberalism of the Hayekian mode".

Milgate, 2011) along with the emergence of globalization and neoliberal ideas, profoundly influenced the manner in which economic modelling was conducted. During the first decades of the post-war era (1950–1970), macroeconomic models were relatively simple, reflecting the prevailing developmentalist paradigm (Lewis, 1954; Rosenstein-Rodan, 1947). These theoretical artifacts emphasized industrialization, state-led economic growth, the utilization of labor surpluses, and the transformation of socioeconomic structures into a highly skilled, more productive activities. While econometric techniques were employed during this period, their role remained secondary or supportive. The skepticism toward their use was largely driven by Keynesian critiques on the methods use, particularly concerning the stability and reliability of estimated coefficients and on capturing the essential characteristics of historical time and uncertainty (Patinkin, 1976; Garrone & Marchionatti, 2004).

In addition, as economic thought evolved[3] the modeling process became more sophisticated and complex. Advances in computational technologies and econometric techniques enabled the development of large-scale equation models, which marked a shift from earlier approaches. By integrating these techniques, economists were able to explore structural relationships in greater depth, refine long-term coefficient estimates, and enhance the precision of their models. Later, modern econometric methods extended the functionality of models beyond basic structural estimation. These approaches were employed to conduct simulations, improve macroeconomic forecasting, and evaluate the efficiency of resource allocation. In the European context, such models played a crucial role in assessing the impact of cohesion funds on regional economic convergence and development, providing policymakers with valuable insights into the effectiveness of these investments.

This transition illustrates how the progression of economic thought – from Keynesianism to the era of globalization and *Washington Consensus* (Williamson, 2004) – reshaped the tools and techniques of macroeconomic modeling. It underscores the dynamic interplay between theoretical advancements and practical applications in economic research, highlighting the continuous evolution of the discipline in response to shifting intellectual and policy landscapes, for example, how to evaluate the efficiency of the allocation of the

[3] See *Notes on the post-war evolution of theoretical models in political economy* on the evolution of the theoretical models of political economy.

European cohesion funds.[4] This observation is pivotal for understanding how the tendency toward model-building in Greece has been intricately associated to its economic integration with the European Common Market. The financial flows and subsidies provided by European institutions, as well as special funds aimed at bolstering domestic consumption and investment, played a dual role. On the one hand, they offered vital support for economic development and modernization of production. On the other hand, they created a demand for analytical tools and methodologies to guide the effective allocation of these resources across various economic activities and sectors. The integration process necessitated the development of models that could address complex questions of resource distribution. These models were needed to evaluate how the EU funds could best be used to stimulate growth, support key industries, and ensure equitable regional development. For example, decisions on whether to prioritize infrastructure projects, agricultural support, or investments required robust, evidence-based approaches.

Furthermore, this demand for sophisticated modeling was not merely technical but also deeply tied to the broader economic and political objectives of accession. Greece's integration into the European common market involved aligning its economic policies with EU standards and demonstrating the capacity to effectively utilize financial support. This alignment necessitated the construction of models capable of addressing macroeconomic concerns such as regional disparities, trade imbalances, and sectoral competitiveness. Over time, the emphasis on model-building in Greece reflected a broader shift in the approach to economic policymaking. Rather than relying solely on ad hoc or reactive measures, the adoption of structured models allowed for more strategic planning, forecasting, and evaluation. These tools provided policymakers with a clearer understanding of the potential impacts of different allocation strategies, thereby improving the efficiency and effectiveness of EU-funded programs. In what follows below, the presentation of the economic models proposed for Greece can be divided into two distinct periods, each reflecting the broader socioeconomic and political context of its time.

[4] The Cohesion Fund provides support to member states with a gross national income (GNI) per capita below 90% of EU27 average, to strengthen the economic, social and territorial cohesion of the Union. For additional information, see: https://ec.europa.eu/regional_policy/funding/cohesion-fund_en

The first period encompasses the post-war Reconstruction era. During this time, the economic models were simpler in form, relied on fewer technical requirements, and were shorter in scope. These models were easier to communicate to policymakers and were deeply rooted in the developmentalist ideology prevalent during the era. They emphasized planning as a means to address the pressing challenges of industrialization, infrastructure development, and economic recovery. However, the economists of this period faced extraordinary difficulties in addressing the macroeconomic issues of their time. Socioeconomic conditions in Greece were exceptionally harsh, marked by widespread poverty, limited industrial capacity, and the lingering effects of war and civil strife. Furthermore, the absence of robust databases and a well-established institutional framework for the domestic market severely constrained their analytical capabilities and the practicality of their proposals.

The second period begins in the mid-1970s, following the fall of the dictatorship and Greece's transition to democracy. This era saw significant transformations in the approach to economic modeling. The models developed during this time became purely econometric in nature, characterized by greater complexity and sophistication. The shift reflected advancements in econometric techniques and the growing demand for more precise and dynamic tools to address the challenges of a modernizing economy. These new models incorporated a wider range of variables, employed more rigorous quantitative methods, and were designed to simulate and forecast economic trends with greater accuracy. This evolution in economic modeling demonstrates the interplay between economic and political trajectory and the tools employed to guide the development of the Greek economy. The transition from the developmentalist and relatively straightforward models of the Reconstruction era (Politakis, 2018) to the more intricate econometric frameworks of the post-dictatorship period highlights not only the advancements in economic thought but also the changing needs and capacities of Greek society during these pivotal decades.

Section 2 explores the interplay between equilibrium economics and Keynesian ideas, which were dominant during the postwar period. Keynes himself was deeply concerned with the way his theories were being interpreted and applied. He expressed particular skepticism toward the emerging field of econometrics, especially in its early applications by Jan Tinbergen while working as a researcher at the *League of Nations*. Keynes feared that the complexities of economic behavior might be oversimplified in econometric models, which could distort the practical implications of his ideas. This concern reflects

broader tensions between theoretical economics and the empirical methods of equilibrium analysis that would later dominate macroeconomic modeling.

Section 3 transitions to examine the pivotal role played by the concepts and practices of economic planning during this era. Planning was not just a tool for economic management but a reflection of the belief that active intervention was necessary to address structural economic challenges. The postwar period was marked by a global consensus that markets alone were insufficient to achieve stability and growth. In this context, planning emerged as a "political religion" shaping economic policy frameworks worldwide. This historical backdrop provides a foundation for understanding the models discussed later in the paper. Section 4 situates the broader discussion of planning within the specific historical and economic context of Greece. The unique economic challenges, including persistent trade imbalances, underdeveloped industrial capacity, and reliance on foreign aid, made planning not just a theoretical exercise but a practical necessity. Greek policymakers and economists sought to adapt international ideas on planning to address the pressing economic problems faced by the country. This section highlights the tensions between external influences and domestic priorities, which shaped the trajectory of economic modeling in Greece.

Section 5 provides an overview of the major economic models proposed during the postwar years. These models reflect the evolution of economic thought, from early Keynesian frameworks to more complex econometric approaches. They serve as both tools for understanding economic phenomena and as instruments of policy advocacy, shaped by the theoretical and institutional contexts of their time. Section 6 examines these models in greater detail, unpacking their assumptions, structures, and implications. The analysis underscores how the power to design and evaluate economic policy has shifted over time. Initially concentrated within state agencies, this power increasingly moved toward central banks and financial institutions. This shift was not merely institutional but also ideological, reflecting changes in dominant theoretical perspectives. As monetarist and equilibrium-based approaches gained prominence, the focus of economic modeling shifted from active state-led intervention to frameworks emphasizing market efficiency and stability.

These sections collectively reveal the interplay between theoretical paradigms, institutional frameworks, and economic policymaking. They underscore how economic models serve as both reflections of and contributors to broader historical and ideological shifts in the history of economic policymaking.

2. Notes on the post-war evolution of theoretical models in political economy

Classical political economy and the dynamics of economic growth

The study of economic growth was a key focus for classical political economy, laying the groundwork for what would become modern theory of economic growth and development (Arndt, 1978). The classical thinkers such as Smith, Ricardo and Marx were deeply influenced by the dramatic societal and economic transformations that took place during the 18th and 19th centuries in the countries of Western Europe, a period marked by the ascendance of industrial revolution and the rapid expansion of industrial capitalism (Hobsbawm & Wrigley, 1999). Classical thinkers aimed to develop a scientific framework to understand the operation and evolution of capitalism, along with the changes and long-term patterns that they envisioned. However, their exploration into the issues of growth and economic dynamics, was more than just a simple response to the changes they observed around them. It also stemmed from a philosophical engagement to the idea of social "progress" that was crucially associated with the advancement of society's material foundations. Their goal was to pinpoint the elements within societies that either facilitated or obstructed this upscaling of the living standards, thereby laying the groundwork for policies designed to influence these elements. Examples of their *policy*-oriented work include Ricardo's critique of the Corn Laws or even Smith's condemnation of mercantilist ideas, and Marx's critique against capitalist exploitation. All undertaken with a view towards fostering progress, understood in terms of increasing wealth, although their political views were deeply differed.

Classical political economists approached the study of economic growth by integrating it within a general view of the economy as a cohesive whole rather than creating a separate theory focused exclusively on, what was later called, *economic growth*. They emphasized the mutual dependence and connection between the processes of production, exchange, distribution, and accumulation and tried to find the *laws* inscribed. According to Meek (1967, p. 187, our emphasis): "To Smith and Ricardo, the macroeconomic problem of the '*laws of motion*' of capitalism appeared as the primary problem on the agenda, and it seemed necessary that the whole of economic

analysis – including the basic theories of value and distribution – should be deliberately oriented towards its solution."

This method led to the recognition that the analyses of value, distribution, and economic growth were closely intertwined, complicating the task of distinguishing studies of economic growth from other autonomous subjects with which political economy was concerned (Salvadori et al., 2014). More particularly, the analysis of classical thought stressed the importance of *surplus*, the portion of the social product left after subtracting the essential costs of production, such as raw materials and wages necessary to support workers. The idea of "surplus" was considered crucial for understanding both accumulation and distribution (Smith, 2017). The distribution of this part of production in the form of profits, interest, and rent played a vital role in the pace with which the process of accumulation was evolved, which was further shaped by the manner in which various social classes demand their share of the total product.

The critical importance of the size and utilization of the surplus, from the standpoint of the entire economy and its growth process, underscored the eminent place of income distribution within classical theory. This aspect was particularly central to Ricardo, for whom the examination of the principles that govern income distribution became a key analytical focus. Apart from the often cited part of the beginning of Ricardo's *Principles* (Ricardo, 1951, p. 1), in a letter to Malthus, he writes that: "Political Economy you think is an inquiry into the nature and causes of wealth; I think it should rather be called an inquiry into the laws which determine the division of the produce of industry among the classes which occur in its formation" (Ricardo, 1973, VIII, p. 278). In this context, the profit rate was deemed vital due to its leading role played in accumulation, serving both as a source of investment capital and as an incentive for further investment.

The notion that competition under capitalism generates a uniform rate of profit across all sectors faces challenges, particularly due to the ever-changing technological landscape, various forms of factor immobility, and entry barriers (Harris, 1988). In classical political economy, understanding how the profit rate evolves alongside capital accumulation is critical, as these changes are key to the conceptualization of a long-term trajectory of capitalism. Ricardo articulated that in a self-contained economy, the profit rate tends to decrease over time due to the intrinsic dynamics of accumulation, ultimately stalling the process towards expansion. Later on, Marx identified this trend of a declining profit rate as a fundamental law, deeming it the "most important law of

modern political economy" (Marx, 1998, *Capital*, III, part 3), a view that extends classical theory, albeit on different grounds. Interestingly, a version of the same concept of a falling profit rate can be also said to appear in neoclassical theory (Harris, 1978, ch. 9), and Keynes touches on it when discussing capitalism's long-term outlook, predicting the "euthanasia of the rentier" (Keynes, 1936, p. 375-6). Similarly, Schumpeter (1934/2011) suggests that the profitability of innovations diminishes over time, reverting the economy to a state of "circular flow" in the absence of new innovations. Despite varying underlying reasons, the idea of a declining profit rate is a notable constant across different economic theories, highlighting its significance in the analysis of economic development.

Hence, classical political economy was primarily interested in the dynamics of production, distribution, and the role of the markets in coordinating economic activity. Their work laid the foundation for the formal study of economic growth, making it a major theme in economic theory. The classical political economy provided the first systematic analyses of how economies may grow over time, the factors that contribute to growth, and the challenges that may arise during the process. In summary, the enduring importance of economic growth as a topic of inquiry within the field of economics was particularly appreciated. From the very beginning, the idea of economic growth remains a pivotal area of study in economics, driving research and policy discussions to this day.

Modelling economic growth – Setting the scene

For many decades, most of the standard textbooks on the theory of growth would begin from the Solow (neoclassical) model (Aghion & Durlauf, 2008; Barro & Sala-i-Martin, 2004; Lucas, 2004) or from the *Harrod-Domar* model presented as a special case of the former. However, growth modelling is more than just another way of presenting the gist of classical notions. The idea of growth permits the dynamic character of the capitalist economy to be vividly articulated and it is a more suitable way to capture the transition from the ideas of classical political economy. The history of economic growth modeling indeed marks a significant evolution in how economists understand, analyze, and predict economic dynamics, time, and the relation between relative scale and economic size. While the *Harrod-Domar* model is often cited as the foundational of Western tradition of economic thought, focusing on the role of savings and investment in driving growth, it is important to recognize that significant developments in economic modeling were also taking place elsewhere, particularly in the Soviet Union. In what follows, the *Harrod-*

Domar is presented and then, we move towards the ideas of Feldman, underscoring the need for planning and investment in the manufacturing sector.

Harrod-Domar model of economic growth

Following Keynes, investment spending should not only be considered as a crucial parameter of aggregate demand. What is more, investment contributes towards advancing the level of production capacity. From this point of view, the *Harrod-Domar* model stands out in the history of economic growth theories, for it emphasizes the role of investment spending in enhancing the economy's productive capacity and for its simplicity that lies in its core assumptions, such as the *constant* capital-output ratio (v or K/Y) as well as the *fixed* capital-labour ratio (K/L). Central to the *Harrod-Domar* model is the economic growth equation, which asserts that the growth rate is determined by a *savings ratio* (s) divided by the capital-output ratio. This simple relation implies that higher s and lower v ratios, contribute to the acceleration of economic growth.

In this model, labour growth (n) is assumed exogenous, and it is related to constant production factor and capital-output proportions. Following a standard version of the model's description, let the economy be comprised by household consumption and by firm savings so that:

$Y_t = C_t + S_t$ [1]

Unless it is necessary for the argument, in what follows, *the time-subscripts are omitted for reasons of simplicity*. In equilibrium, savings are supposed to be a share of income potentially dedicated to investment ($S = I$). In that case, equation [1] becomes

$Y = C + I$ [2].

By default, growth is linked to investment so that the capital stock increases by the same rate. Moreover, let δ denote the rate of capital depreciation. Hence, the *new* level of capital depends by the investment level realized in the previous period:

$K_{t+1} = (1–\delta)K_t + I_t$[3]

Moreover, v, is defined as the "capital-labor ratio", K/Y or $\Delta K/\Delta Y$ (or $I/\Delta Y$), and total savings are seen as a fraction (s) of total income:

$S = sY$ [4]

From the above, v can also be written as $K = vY$ and equation [3] becomes:

$vY_{t+1} = (1–\delta)vY_t + sY_t$

Dividing by v and then, by Y_t, we end up:

$G = [Y_{t+1} – Y_t] / Y_t = s/v – \delta$ [5]

Equation [5] is called the "fundamental equation" and captures the very essence of the Harrod-Domar growth theory, stating that the growth rate is generally generated by the rate of savings over the capital-output ratio. Thus, economic growth requires a level of savings that would be greater to the capital-output ratio, and the result of the *s/v*, would also be greater to rate of depreciation.

The model has gained significant traction in the field of economic growth, particularly during and after the third quarter of the 20th century (see for example, Lewis, 1954) and has set the scene for the models to follow. Nevertheless, the importance of the Harrod-Domar way of economic thinking, resides on the effect that it had on early growth strategies. What this model actually suggests is that the primary challenge for developing economies was to search for ways to augment resources allocated to capital formation. This model has been utilized by economic planners to set growth targets and to compute the savings ratios required to achieve them. "It suggested that the central developmental problem was simply to increase resources devoted to investment" (Bhagwati, 1994).

Though widely used, the model was not without its critics. A major point of contention was its assumption of a constant *v*, which negated the variable efficiency of investment and was seen as an unrealistic representation of economic dynamics. Additionally, the model's presumption of zero substitutability between capital and labor raises two basic problems, that of *unstable* equilibrium growth, commonly referred to as the "knife-edge" problem and the existence of steady-state equilibrium. A steady-state growth path in full-employment can only be achieved under extremely special circumstances, beginning by the idea that the model has been built upon the notion of rigid technology incorporated within the function of production i.e., to remain in equilibrium, *K* and *Y* must grow at the same pace. Moreover, since *K/L* is also assumed to be fixed, if the labour force tends to grow at *n*, then it holds that in equilibrium, $G = s/v = n$. But, as suggested by Solow (1988), this case, can only happen by a "miraculous stroke of luck".

The model includes three distinct rates. G_a is the growth rate that actually exists i.e., $G_a=s/v$, compared with two additional and conceptually distinct rates. The first, is the "natural rate of growth" G_n, which is the maximum (and socially optimal) rate growth

attainable, given by the growth rate of the labour force (n) and by that rate of per capita output that is attributed to technical progress (τ): $G_n=n+\tau$. The second is the "warranted growth rate" which is consistent with: (i) the decisions on savings, taken by the households (s_d) at the beginning of the period (ex-ante), and (ii) the capital-output ratio (v_d) that matches with the level of investment, compatible with the expectations entrepreneurs would have at the beginning of the period – therefore $G_w=s_d/v_d$. To put it in a slightly different manner, the "warranted" refers to that rate "in which producers will be content with what they are doing" (Harrod, 1964, p. 81) or that which maintains an equilibrium between realized savings and planned investment.

Each of these growth rates are considered autonomous against the other two, but there is no requirement of them being equal or unequal. As long as the two problems raised above, the "knife-edge" issue refers to the convergence between G_a and G_w, whereas the steady state equilibrium refers to the convergence between G_n and G_w. It can be said that G_w is defined so that is compatible with the realized level of effective demand. The producers are supposed to find out that their expectations concerning the level of sales are satisfied. However, since there is no theoretical reason implying that the rates should coincide, differences between them – which are determined by several different factors – form the dynamic character of the system of equations. From the above it is easy to see that the Harrodian system is inherently unstable. Suppose, for example, that $G_a>G_w$, meaning that producers decide to raise their planned investments so that the demand for capital will be greater than that which can be covered by the entrepreneurial desire to invest. Capital producers are expected to rearrange their plants to meet the increased demand, but in that way the accelerator works so as the gap between them is widened.

During the years that followed Harrod's model, two different paths were followed. The first, which is presented in the section below, concerned the neoclassical tradition of which is based on the variation of v. The second, refers to the Kaldorian vision of growth, also examined by Joan Robinson, emphasizing the distribution of income and the savings ratio (s). Over time, it became evident that the *Harrod-Domar* model has oversimplified the complexities of economic growth. Most importantly, it seems that it has failed to account for critical factors such as the efficiency of the policy framework, the structures incentivizing investment, and the actual productivity of the accumulation process.

Despite such criticisms however, and its diminished prominence in academic circles, the *Harrod-Domar* model continues to exert influence, particularly among

economists in major international financial institutions. The model's straightforward approach has revised the interest of scholars on capital accumulation and investment, often overshadowing other vital elements essential for sustainable economic growth. In retrospect, while the model has been pivotal in shaping initial understandings of economic growth, its limitations and simplifications paved the way for the emergence of more comprehensive growth models in subsequent years. Lastly, the Harrod-Domar model should be understood as simple way of describing the conditions of future growth, especially of those countries which though they had experienced considerable development in the past but are at a critical juncture that would affect their future path.

Feldman model of economic growth

Domar's engagement with Marxian economics and its modeling of economic growth reveals a refined and evolving perspective (Domar, 1946, p. 70; Domar, 1952, p. 480). Initially, Domar expressed his skepticism about the practicality of the Marxian theory, particularly focusing on the reproduction schemes, which divided the economy into two sectors, one for producer and, another for consumer goods. Domar saw these schemes as overly simplistic and flawed in their handling of capital dynamics, referring to them as a "logical monstrosity" and likening them to a "stone axe" due to the confusion they presented between stocks and flows – fundamental to understanding economic variables. Despite his criticism, however, the significance of Marx's focus on economic growth and the relationship between capital accumulation and employment was acknowledged. Domar lamented the delay in developing a theory of economic growth along Marxian lines, attributing it to the excessive defense of Marx's legacy by his followers. Yet, Domar's perspective began shifting away from mainstream theorizing as he encountered more sophisticated models emerging from the Soviet Union in the 1920s, notably that of Grigory Feldman's work (Feldman, 1928/1964). These models, which were based on Marxian reproduction schemes featuring a multi-sector approach, demonstrated a complexity and development level that Domar recognized as superior to similar efforts generated in the Western, with the exception of Leontief's input-output analysis.

This change became particularly evident after the study of Feldman's model in the mid-1950s. While he maintained his critique regarding the stock-flow confusion in Marxian schemes, especially in their application to profit rate calculations (Sweezy,

1942/1970), Domar began exploring the potential utility of these models for understanding growth dynamics. This reassessment signifies a key moment in Domar's economic thought, highlighting his openness to reevaluating previously held positions in the light of new evidence.

This evolution in Domar's views underscores the complexity of economic thought and the importance of cross-fertilization between different schools of economic theory. It also illustrates the ongoing dialogue between Western and Soviet economists during a period of significant ideological division. Domar's eventual appreciation for the sophistication of Feldman's model, despite its roots in Marxian economics, reflects a broader recognition of the value of diverse analytical frameworks in enriching the study of economic growth. Moreover, Domar's engagement with these models, even in critique, contributes to a deeper understanding of the challenges and opportunities in modeling economic processes, highlighting the necessity of grappling with the nuanced interplay between theoretical abstraction and empirical application.

The Feldman model represents a pivotal contribution to economic growth modeling from a Marxian perspective. Unlike the *Harrod-Domar* model, which is somewhat simplistic in its assumptions about the relationship between savings, investment, and growth, the Feldman model is a multisectoral model that delves into the complexities of the industrial structure (Feldman, 1928/1964). Feldman emphasized the importance of capital accumulation and the redistribution of investment across different sectors of the economy—particularly between heavy (capital goods) and light (consumer goods) industries. This model was sophisticated for its time, as it attempted to outline how a centrally planned economy could allocate resources to maximize growth and industrial development.

Feldman, adapted the Marxian model such that Department I covered all activities boosting productive capacity, while Department II included those maintaining output levels, although this categorization was not always practical to apply (Domar, 1957/1982, p. 225). Furthermore, in line with thw Marxian framework, it was impossible to transfer existing capital stock between sectors, yet the allocation of investment between them remained variable. Hence, the distribution of consumption and investment in the overall output was influenced not by saving tendencies but by the capital stocks and capital coefficients specific to each sector. The inherited capital structure influenced the choice of output composition. The crucial factor driving economic growth was identified as the capacity of Deparment I to produce capital goods,

as determined by the share of total investment it retained. If this capacity is limited, the potential saving propensity cannot be transformed into investment, leading to its underutilization.

From the above, it becomes clear that one of the model's key insights is the emphasis on the prioritization of heavy industry as a means to fuel further economic growth, under the assumption that a strong capital goods sector would lay the foundation for sustained expansion across the economy. This approach reflected the broader economic strategies pursued in the Soviet Union, which focused on rapid industrialization and the development of heavy industry. Feldman adopts a more structuralist point of view, for it is acknowledged that savings may not be able to be transformed into investment, unless the structure of economic activity is altered. The model assumes that there are real constraints that need to be overcome.

Following Feldman (1928) and Mahalanobis (1953), i) the economy is comprised of two sectors, one producing capital goods (*k*) and another producing consumer goods (*c*), ii) capital machinery and equipment, once installed in one of the two sectors, cannot be transferred or shifted to another[5] – capital is considered non-shiftable, iii) in both sectors technological coefficients are assumed fixed, iv) capital is a scarce resource while labour is generally considered to be abundant (see also Lewis (1954)), v) in the simple form, depreciation is not taken into account. A more advanced and complex version is presented by Bose (1968). vi) An additional, simplifying assumption is to take the model for a closed economy – capital cannot be imported and vii) production between the two sectors is independent.

Let μ the percentage of capital output used in the sector producing capital goods and (1-μ) to that of consumption goods. Sector output is given by fixed coefficient technologies such as $Y_k = min\left[\frac{K_k}{v_k}, \frac{L_k}{u_k}\right]$ and $Y_c = min\left[\frac{K_c}{v_c}, \frac{L_c}{u_c}\right]$. Y_k and Y_c are the capital and consumption output, the *K*s and *L*s stand for the quantities of capital and labour used in each sector and the *v* and *u* are the fixed coefficients, respectively. It can thus be written that $Y_k = {K_k}/{v_k}$ and $Y_c = {K_c}/{v_c}$. According to Jones (1979, p. 116) this is consistent with the stylized facts that appeared in the Soviet Union during the 1930s.

[5] For a detailed discussion on this see Weltzman (1971).

Given that the total output of the sector producing capital or investment goods is $I = Y_k = K_k/v_k$, the rate of change can be written as $\dot{I} = \dot{Y}_k = \frac{1}{v_k}\dot{K}_k$ [6]. Moreover, $\dot{K}_k$, the rate of change of the capital stock in sector *k* should equal the sector's level of investment, hence: $\dot{K}_k = I_k = \mu I$ [7].

Feeding [7] into [6], we obtain: $\dot{I} = (1/v_k)\mu I$ which gives

$$\frac{\dot{I}}{I} = \frac{\mu}{v_k} \qquad [8]$$

The rate of growth of investment increases with the proportion of investment goods output dedicated to the production of more investment goods. Alternatively, a decreasing capital-output ratio of the *k*-sector would positively affect the rate of investment. From this perspective, one may make sense of the focus of India's second five year plan (1957-'61) in producing capital goods (Bareau *et al*., 1957; Chakravarty, 1987; Nanda, 1998, pp. 207–221).

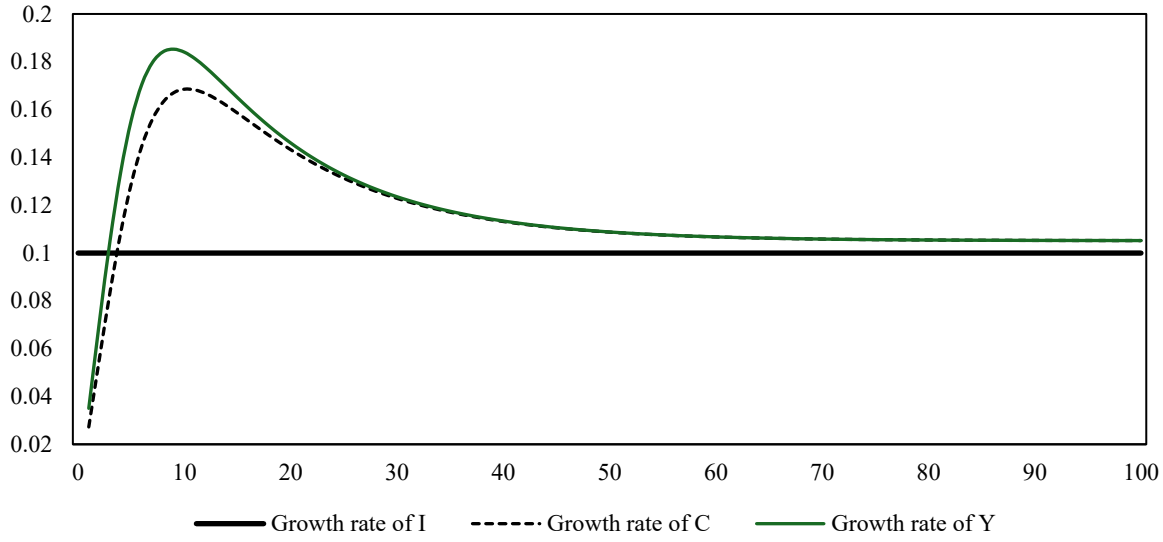
In an analogous manner $C = Y_c = K_c/v_c$ [9]. C stands for consumption and the relationship can be converted into rates of change so that $\dot{C} = \dot{Y}_c = \frac{1}{v_c}\dot{K}_c$ [10]. As in the above, the share of total investment equals the new capital in sector c: $\dot{K}_c = I_c = (1-\mu)I$ [11]. By substituting [11] in [10] and dividing by *C*, we obtain:

$$\frac{\dot{C}}{C} = \frac{(1-\mu)}{v_c}\frac{I}{C} \qquad [12].$$

The growth rate of consumption is linked positively with investment (the rate of growth of which is given by equation [8]). Two propositions can be deduced from the above model. First, the two growth rates, that of investment and that of consumption, are not necessarily equal. As time goes by, however, consumption grows so that it will eventually reach the point of investment growth (μ/v_k). Second, the total rate of growth will not be equal to the rate of investment, but in the long-run, it coincides with that of the investment output.

In comparing the Feldman model to the Harrod-Domar model, it becomes clear that the former offered a more nuanced understanding of the structural dynamics of an economy and the strategic choices involved in planning for economic growth. Its influence, particularly in the context of centrally planned economies, underscores the diversity of thought in the field of economic growth modeling and the importance of considering a wide range of theoretical perspectives when studying the complexities of economic development.

Figure: Long-run convergence in Feldman model of economic growth. Calculations are made for a constant investment rate of growth at 10%, μ=0.3 and a simplifying assumption of $v_k = v_c = 3$.



Note: The figure was generated using Domar's equations as presented in Domar (1957/1982, p. 232).

The IS-LM model

The well-know *IS-LM* model is composed of two markets, one for goods and one for money. The *IS* curve is designed to depict a locus of several equilibrium combinations between income and the interest rate, on the assumption that the latter is negatively associated with investment. Thus, the schedule takes a downward slope. In a similar fashion, the *LM* curve represents a set of equilibrium positions between income and the interest rate. Money is considered exogenous i.e., its quantity is decided and given by the relevant monetary authorities. The *LM* schedule assumes a certain quantity of money, unchanged expectations towards the future and a stable level of prices. Hence, an increase in the supply of money on the assumption of an unchanged *IS*, is expected to increase output and lower the rate of interest.

What the *IS-LM* framework actually designates, is that both the fiscal and the monetary policy can have a significant effect on output (thus, employment) and the rate of interest, depending on their relative elasticities. In the orthodox Keynesian tradition, as opposed to the level of investment, the demand for money is supposed to be rather

sensitive to changes in the rate of interest. Accordingly, within this framework, fiscal policy tends to be more efficient and to generate stronger effects.

Assuming that the price level is fixed, aggregate expenditure (*E*) is associated with an autonomous part (*A*), one that is analogous to the level of output (*cY*), and one which is negatively linked with the rate of interest (*ar*). Thus $E = A + cY - ar$. Obviously, $E = Y$ refers to equilibrium between output and the level of expenditure. On the other hand, the demand for money (in real terms, *M*/*P*) is also related to income *mY* and is also negatively linked to the level of interest rate (*br*), thus $M/P = mY - br$. The supply of money is given as an exogenous parameter ($\bar{M}^s$). By reconfiguring these relationships, the following result is obtained:

$$Y = \frac{1}{1-(c-{}^{a}/_{b}m)}A + \frac{1}{m+{}^{b}/_{a(1-c)}}\frac{\bar{M}_s}{P} \qquad [1]$$

The *a*/*b* ratio, signifies the relative weight given to fiscal policy. When low, the real part of the macroeconomy presents a greater effect in income and the multiplier attributed to fiscal policy is stronger than that which refers to monetary policy. Seeing from this perspective, the model finds a foothold within Keynesian orthodoxy, but deviates substantially from the later monetarist views arguing that, in the long-run, the overall result of government spending on aggregate demand would be negligible.

These effects cease to be the main results of the *IS-LM* model, if prices and money wage are considered flexible. The "Pigou effect", has significantly contributed to the establishment of the "neoclassical synthesis" through which, the "Classical Model" made its great come back. A fall in prices has a positive effect on real wealth, that may end up increasing consumption, pushing the economy towards full employment. One of the most fervent advocates of that trend which dominated the scene during the first the post-war decade, Harry Johnson asserted that "the Pigou effect finally disposes of the Keynesian contention that underemployment equilibrium does not depend on the assumption of wage rigidity. It does." (Johnson, 1964, p. 264). Thus, under full flexibility of almost all the parameters, the *General Theory* became itself a special case of the equilibrium model (Fletcher, 2002).

One of the most famous extensions that spring up from this pronounced flexibility, is the Phillips curve. At the height of *neoclassical synthesis*, Phillips exerted that "when the demand for a commodity or service is high relative to the supply of it we expect the price to rise, the rate of rise being greater the greater the excess demand [...] It seems

plausible that this principle should operate as one of the factors determining the rate of change of money wage rates" (Phillips, 1958, p. 283). Phillips intention was to establish a negative relation between inflation and unemployment and to emphasize his reluctance over exchanging between a high level of prices for a high level of employment. High prices were almost becoming synonymous to low levels of unemployment. But Phillips' empirical investigation was not adequate for his concept to gain proper attention. A way out was offered by (Lipsey, 1960). The Phillips curve was embraced by the orthodox Keynesian school for it seemed to offer a demand-driven cause for inflation. More importantly, there was no need to assume fixed prices in the *IS-LM*, anymore. More output would be the result of higher employment, which in turn tends to increase wages. From the latter, the wage-driven inflation was just a minor step waited to be made.

Solow model of economic growth

What has come to be known as the standard "neoclassical model of economic growth" should as well considered a seminal work in the field of economics and it was developed during the 1950s by Solow (1956) and Swan (1956). This model marked a significant evolution from the earlier *Harrod-Domar* model by introducing more flexible capital-output and capital-labor, ratios. Solow's perspective has become a foundational model in understanding the dynamics of the basic macroeconomic variables, focusing on the roles of savings, population growth, and technological progress in a closed economy. At its core there are a few critical assumptions. First, the economy is viewed as a single-commodity system, utilized for both investment and consumption. Second, the model operates within a closed economy, devoid of international trade or government sector involvement, and posits that savings automatically equate to investment. This "heroic" assumption ensures that the economy is always producing at its potential output.

Central to the Solow model is the neoclassical aggregate production function, expressed mathematically as $Y=AF(K,L)$.[6] In this equation, Y represents the total output, K stands for the capital stock, L is the labor force, and A signifies the level of technology. A plausible way of thinking the production is the following: "The production function

[6] This function is "well-behaved" if the three following conditions, also known as "Inada conditions" (Inada, 1963) are satisfied: (i) for all $K>0$ and $L>0$, F(.) shows positive but diminishing marginal returns of both factors. Hence, $\partial F/\partial K>0$, $\partial^2 F/\partial K^2<0$ and $\partial F/\partial L>0$ and $\partial^2 F/\partial L^2<0$. (ii) The production function is characterized by constant returns to scale so that it is assumed homogeneous of degree one i.e., $F(\lambda K, \lambda L) = \lambda Y$. (iii) As $k=K/L$ tends to infinity, the marginal product of capital tends to zero.

should not be viewed literally as a description of a specific production process, but as a mapping from quantities of inputs into a quantity of output [...] When a country doubles its capital stock, it does not give each worker twice as many shovels. Instead, it replaces shovels with bulldozers. For the purposes of modelling economic growth, this change should be viewed as a movement along the same production function, rather than a shift to a completely new production function" (Mankiw et al., 1995, p. 281). Being homogeneous of first degree, if $\lambda = 1/L$, the production function can be rewritten as $Y/L=F(K/L)$ or it takes the following form:

$$y = f(k) \qquad [6]$$

where $y=Y/L$ (output per worker) and $k=K/L$ (capital-labor ratio). Following this, under a given state of technology and for every k, it holds that $f'(k) > 0$ and $f''(k) < 0$. From an economic perspective, it is important to note that equation [6] refers to economies where no further technology advancement are expected to be made and where all potential benefits that come from divisions of labour have been completely exhausted. As k advances, the economy is supposed to increase its y, but the impact of this relation slowly diminishes, indicating that the process of capital accumulation generates a faster growth in countries lacking capital equipment. The marginal product of capital should be much higher in developing countries which, in case of free international capital mobility, would also expect to lead to capital inflows going from rich countries to poor.

The model also delves into the dynamics of capital accumulation and consumption. To understand how it works, the concept of savings needs to be appreciated. In a closed economy, savings (S) should necessarily be equal to investment (I) and thus, $Y = C+I = C+S$. The latter, can also be written as:

$$Y = C + sY \qquad [7]$$

Capital accumulation is defined by the equation $dK/dt=sY-\delta K$, where s stands for the savings rate, Y is the output, and δ refers to the depreciation rate of capital. When analyzed on a per-worker basis, this equation is expressed as $\dot{k} = dk/dt = sy - (n + \delta)k$, offering insights concerning the evolution of capital per worker. In the latter expression, n stands for the growth rate of the labor force and the changes in capital stock are captured by

$$K_{t+1} = I_t + (1 - \delta)K_t = sY_t + K_t - \delta K_t$$

which, after some algebraic manipulations, if written in intensive form, we end up as follows:

$$\dot{k} = sf(k) - \delta k \qquad [8]$$

A pivotal concept of the Solow model is the steady-state, a situation in which the rate of capital per worker remains constant. This state is critical as it implies that the long-term growth of output per worker is predominantly driven by technological progress (*A*). Thus, at k^*, the steady state level, $\dot{k} = 0$, indicating that the per worker investment is equal to the level of per worker capital depreciation: $sf(k^*) = \delta k^*$. Including the growth of the labor force (*n*) within [8], the fundamental differential equation is derived as follows:

$$\dot{k} = sf(k) - (n + \delta)k \quad [9]$$

Consequently, *(n+δ)k* represents the "break-even" investment which is necessary for per worker capital stock to remain steady. On the other hand, if *sf(k)>(n+δ)k* this means that k is expected to raise and by construction, the steady-state level of capital per worker, k^*, is gradually approached. Figure 1 depicts the dynamics of equation [9].

As it is shown, at k_1, the level of investment per worker is greater than what is necessary to maintain the labor force and to replace the capital depreciation. Hence, the economy is expanded, as the lower part of Figure 1 shows, depicting the rate of change of capital, until the k^* is reached, where the two rates are counterbalanced.

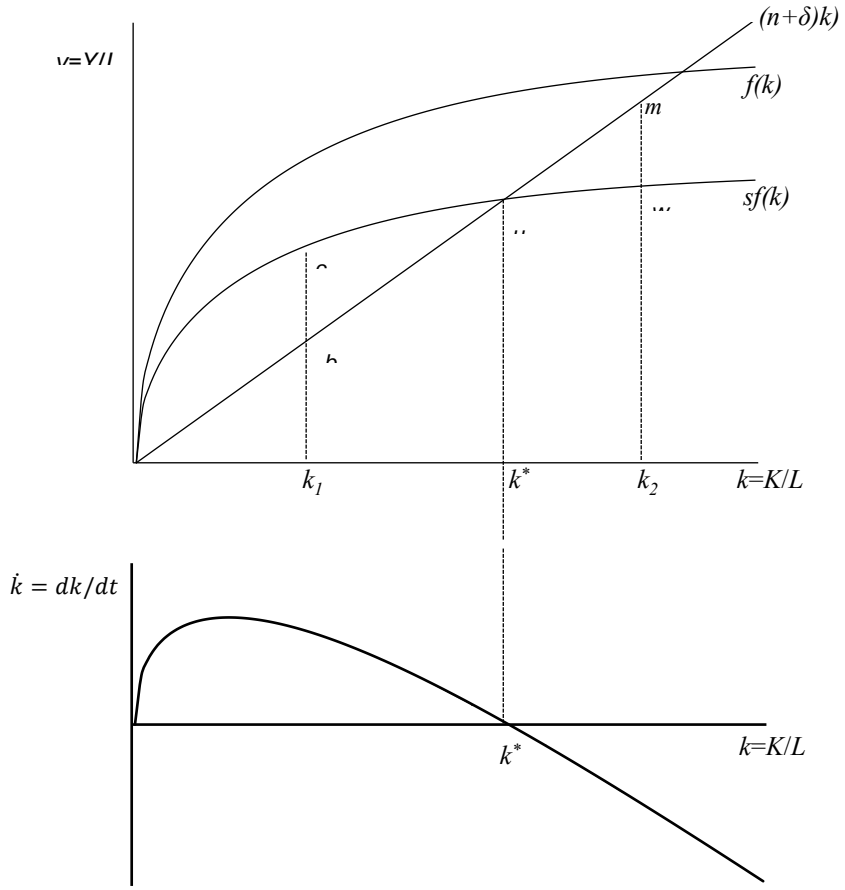
The model presented so far does not include technological progress. Equation [10] presents a Cobb-Douglas production function in which technology is incorporated as an exogenous factor. This treatment of technological progress as an external element, not influenced by the economic system itself, is often cited as a limitation of the model.

$$Y = AK^{\alpha}L^{1-\alpha} \qquad [10]$$

The superscripts *α* and *1−α* are the shares of capital and labor in total output, respectively. In this formulation, due to constant returns, *Y/L* is not affected by the scale of output and for a given initial technology A_{t0}, it is derived that *Y/L* is positively related to *K/L*. Accordingly, production function can be rewritten in intensive form as:

$$Y/L = A_{t0}(K/L) = A_{t0}(K^{\alpha}L^{1-\alpha})/L = A_{t0}(K/L)^{\alpha} \qquad [11]$$

Figure 1: The Solow model of economic growth



Which in the same way as equation [6], it can also be transformed into $y = A_{t0}k^{\alpha}$. In this relationship, the technological progress operates exogenously. For example, any advancement in technical knowledge upscales the function and becomes a central explanatory variable for steady state growth. However, the Solow model cannot, by construction, provide any analysis as to how this new technology appears and how knowledge is generated. What has come to be known as "Solow residual" can also be understood as "a measure of ignorance" (Abramovitz, 1956).

Unlike the case of long run growth, the Solow model leaves enough room for capital accumulation to determine productivity if technical knowledge is assumed to be *embodied* in the new capital machinery, tools, and other innovative factors applied. According to this distinction, disembodied technical progress is supposed to affect the input factors that are only currently employed. Whereas the classical political economists and Karl Marx, in particular, were clear about the relation between the progress of new techniques on economic growth, the issue was somehow neglected. Despite certain critiques, particularly regarding its assumptions on technological

progress and the role of capital accumulation in sustainable long-term growth, the Solow model remains a cornerstone in modern macroeconomic theory.

To sum up, the model predicts that the rate of total output is determined by population growth (*n*) and advancements in technological progress (*A*), whereas a steady state equilibrium would be eventually reached. At that point, the rate of growth would depend on *A*. Moreover, given *δ*, output per worker is determined by savings (*s*) and *n*. After steady state is achieved, an increasing s does not advance the long-run growth further, but results in a higher level of output per worker. What sets the Solow model apart is its focus on technological advancement as a driving force for economic growth, rather than capital accumulation. This insight shifted economists' perspectives, emphasizing the role of innovation and technological change in economic growth. Moreover, the model provides a framework for understanding the effects of policy decisions and external factors on growth trajectories. For instance, it suggests that investments in education and technology can lead to more *sustainable* growth than merely increasing capital investment. Additionally, the Solow model has also being used to explain why different countries grow at different rates.

According to this theoretical perspective, poorer economies tend to grow faster than richer ones, eventually leading to a convergence in living standards, assuming similar savings rates and access to technology. "If countries are similar with respect to structural parameters for preferences and technology, then poor countries tend to grow faster than rich countries" (Barro, 1991, p. 407). This aspect of the model has been widely used to analyze and predict growth patterns in developing nations. Overall, its enduring relevance lies in its simplicity, its ability to incorporate key economic concepts as variables, and its profound implications for economic policy and long-term planning. It remains a foundational tool in the field of mainstream economics for analyzing the dynamics of growth.

Post-war developments

The beginning of the post-war era has occasionally been highlighted by the declaration of the Truman Doctrine and by the international conference held at Bretton Woods, which began in 1944. The major aims of this conference were the restoration of a system of exchange rate stability and the coordination of policies capable to secure "full-employment" on the condition of balance of payments (BoP) equilibrium. These two goals

were about to play an important role throughout the years to follow and were raised as issues of serious tensions among the major western countries.

Though the Bretton Woods attempted to establish a framework of multilateral agreements as far as the international trade was concerned, promoting currency convertibility. However, shortly after the agreement, inflation hit some of the most advanced countries in west, due to the high demand generated for reconstruction. The short-term loans offered by the IMF to help countries correct their current account deficits were not enough, and the goals set by international organization seem to fade. The significance of the new body of international affairs and policy coordination is stressed by an excerpt from the speech of the managing director at the Fund's board, indicating that "there is one international monetary policy-making body in the world, and only one; the Fund. It should therefore be associated with any movement, any organization having a connection with international monetary policy" (cited in Nishikawa, 2019, p. 7).

The difficult decisions faced by the many different interests of the countries whose currencies were unable to secure convertibility, had to be resolved by the IMF which acted "as an international empire", intervening for conciliation on high priority issues. One of them was certainly the level of minimum reserves that each country requires to hold for achieving convertibility. The latter, obviously, was about to influence the way of conducting economic policy.

An issue of utmost urgency was that of "dollar shortages" causing severe inflationary pressures. Thus, inflation challenges were about to become a central theme of the IMF staff examining ways and policies to control price-hikes, urging the countries to adopt restricted policies that would help maintaining its par value. Thus, not long after its inception, the IMF was moving away from the policies of *full-employment* and balance of payments equilibrium and headed towards a tighter mix of domestic policies that would bring down prices. In the First Annual Report on Exchange Restriction published by the Fund its reads "experience has clearly shown that inflation undermines the exports of a country, not only by raising internal costs, but also by tending to shift products from export to domestic consumption [...]. If exports fail to move to foreign markets in adequate volume, the resulting disequilibrium in the balance of payments cannot be corrected by imposing or tightening exchange restrictions. The only alternatives are a reduction of domestic costs by a monetary contraction or a reduction of selling prices abroad by an exchange devaluation" (IMF, 1950, p. 33). As it is clear, these

recommendations were distant themselves from the initial commitments articulated by the Bretton Woods, especially as far as the priority of "full-employment".

What the previous part actually suggests is that when the level of national income is at full-employment level, the current account can only be improved by restraining domestic demand. From the perspective of the "absorption approach" (Alexander, 1952) developed by the IMF staff at the time to bring inflation under control, the current account (CA) equals the difference between full-employment GDP and "absorption" (*A*, consumption plus investment) hence, $CA = Y_{FE} - A$. Thus, it was maintained that external devaluation would not be adequate to correct for the level of imbalance. Domestic income would also be responsible – at least partly – for high prices (Black, 2019, p. 63). Especially in the case of full-employment, national product cannot be easily increased to adjust to demand for exports that would be caused by a decline in prices. The Fund's lending policy had, thus, to follow certain criteria, that would have to be fulfilled unless countries wanted to have access to IMF's resources.

Another aspect revealing a tendency for certain policies, is found on the way the doctrine of liberalization was promoted. The IMF presented the "import substitution" policies (Irwin, 2021) as an impediment to the potential earnings of the countries aggreed in participation to international cooperation. To cope with balance of payments problems, "the majority [of country-members] does rely on such restrictions [...] Limitations on imports by one country, through exchange or trade restrictions or other devices, restrict earnings of other countries" (IMF, 1952, pp. 4–5). As a consequence, it becomes clear that the idea of "liberalization" was crucial to the IMF policy profile and by the 1955 the Fund has decided on a policy-mix that oscillates between external and *internal* adjustments to operate as stabilization mechanisms. It is clear that the new consensus under formation was proposing the adoption of a set of tighter macroeconomic policies. The convertibility of the currencies meant the acceptance of certain commitments through which national economies were earning their place in becoming credible partners on the basis of international trade. Countries' "full realization also requires that countries whose position are still weak should shape their economic policies so that they can progressively dispense with the supports afforded by discriminatory import restrictions, bilateral arrangements, and other special exchange devices. It requires, too, that countries for which balance of payments problems have not been matter of any serious concern should also adopt policies appropriate to the strength of their positions [...] Nevertheless, the primary responsibility for effective action rests

squarely upon the individual country directly concerned [...] this means the timely adjustment of exchange rates, and above all it requires the application of domestic monetary and fiscal policies that will ensure internal financial stability" (IMF, 1954, p. 13). Hence, stability would require a series of anti-inflationary and wage-control control, so that the competitive position of a country to be maintained.

Throughout the decades, the IMF has undergone several revaluation processes, such as the incident of high multipliers (IMF, 2012a; 2012b) and has revised its views on economic orthodoxy, especially on the fiscal side of economic policy (see Clift, 2018). The exchange of ideas within the Fund, however, does not resemble the process that takes place within academic discussions which is mostly based on theoretical differences. Dispute between Keynesian or neoclassical features of the Fund's main model of economic policy is based on arguments about the technical validity of several ideas such as the "crowding out" – the permeated notion that government expenditure halts private initiatives – and fiscal multipliers – the effect of government expenditure on total output. From time to time, the Fund has recalibrated its basic model, but in essence, these changes display the dynamics of methodological discussions that occur internally.

Changes in views and in the way of thinking about how economy should operate, may also challenge the approach towards IMF as a "neoliberal" institution. This "continuity thesis" has been supported by several authors (see Nelson, 2014), arguing that the internal discourse on economic thinking has not violated the homogeneity of the Fund. On the other hand, Blyth, (2013, p. 54) shows that on the field of fiscal policy in particularly, a lively debate has been developed among IMF researchers criticizing the validity of "expansionary fiscal consolidation". Apart from these standpoints, during the mid-1950s, a consensus did appear around the "simple" Polak model, designed to examine the relation between national income and balance of payments.

Polak's model

Within this historical background, countries were seeking for credit, so they be able to finance their deficit reserve positions. In the absence of adequate high quality statistical records on vital measures, such as the GNP, the model focuses on banking/financial data as well as, trade data. The policy that emerged was termed as "Monetary Approach" and owns much to Jacques Polak, a member of the Fund's research department (Polak, 1957;

1997), whose emphasis was given to one crucial variable which the authorities could most easily manage i.e., the generation or confinement of credit.

"Acceptance of the Keynesian analytical framework by the economics profession had left a gap between problems that could easily be solved with the help of Keynesian tools and those frequently encountered by officials concerned with monetary and balance of payments questions. In the construction of a theoretical basis for solving such problems and in the design of procedures for quantitative analysis in this area, much of the innovative work was done by the staff of the International Monetary Fund" (Rhomberg & Heller, 1977, p. 6). From this perspective, the Polak model is well grounded upon the quantity theory of money.

Polak takes the view that the current level of national income is based on that of the previous period plus new quantity of money (ΔM_{St}) thus, $Y_t=Y_{t-1}+\Delta M_{St}$. Moreover, the quantity of money is determined by the level of bank credit (D_t) and foreign reserves (R_t), which change in tandem with the movements of the current account and especially with the trade balance ($X_t - I_t$).[7] However, it is supposed that total imports are determined according to $I_t = mY_{t-1}$, with m indicating an approximation of the propensity to import. It follows that since D is positively related to national income, the countries' current account is expected to deteriorate, generating external pressures. The model thus concludes that D, in both private and public loans, has to be closely monitored by agencies, unless the current account is adequately controlled.

The previous views imply that the IMF sought to promote growth through price stability by placing a ceiling on credit expansion. Improving the country's foreign reserves, however, might also lead to an increasing capacity of new money supply that would potentially drive prices up. In a retrospective evaluation of the model, Polak (1997a, p. 18) has observed that "up to the 1970s, this possible outcome did not cause much concern [...]. But developments in the 1980s, and even more strikingly in the 1990s, have shown how such overperformance might also lead to shockingly high inflation". As international capital was becoming more easily flowing around the globe, economic ideas were shifting towards a tighter fiscal policy and several parameters such as the exchange rate and the interest rate expectations were needed to be associated with price outcomes.

[7] This assumes that the capital, as well as other minor flows comprising the current account can be negligible. Moreover, the exchange rate is supposed to be invariant.

Blanchard et al. (2010) argue that before the 2008 crisis, monetary policy was perceived as potentially more effective than fiscal measures in dealing with macroeconomic imbalances. Following the consensus of the Fund, expect of some extreme cases that were fervently supported crowding out, fiscal multipliers were considered low (Hemming et al., 2002). It would seem that its stance on fiscal policy was not wholeheartedly Keynesian, neither New Classical.

The New Classical school

During the 1970s, the Keynesian skepticism over the incapacity of the market to generate optimal outcomes had retreated. Except from the monetarist arguments against Keynesian models advocating the merits of expansionary demand policies for resolving unemployment, a notably more severe criticism appeared by Robert E. Lucas Jr. What came to be known as "Lucas' critique" was proved much stronger and able to capture the watershed historical changes that occurred during the 1980s at an international level. Lucas critically objected against the exogeneity of individual expectation and the way they were featured in the orthodox Keynesian models. For that purpose, drawing from the early works of Tinbergen (Keuzenkamp, 1991), this school proposed the idea of "rational expectations hypothesis" (REH) for endogenizing expectations, within the model.

Expectations are undoubtedly central at key economic activities among stakeholders, such as the process of wage bargaining. However, REH is more than just a recognition of its contributing value. It asserts that expectations are not merely passive or adaptive responses to past events, but are actively formed based on available information and the knowledge of the prevailing economic theory. Its introduction provides dynamism on mainstream economics and intends to give particular emphasis on the forward-looking feature of economic decisions.

REH is a central tenet underlying the new classical model. Its initial application, however, was to the microeconomics of John Muth, 1961), rather than to macro-behavior. Following REH, individual expectations are understood as informed predictions, formed by using all information available to economic agents about future economic variables, such as inflation rates or market trends. RHE has replaced the adaptive expectations hypothesis, which was dominant in Keynesian models where expectations were considered *exogenous*. Moreover, at its extreme version, expectations of economic variables by agents align with the true mathematical conditional expectations of those

variables. If subjective expectations coincide with objective predictions based on available information, economic agents are assumed to have used all the information possibly available. In that case, the hypothesis can be expressed as $P_t^e = E(P_t^t|\Omega_{t-1})$, where P_t^e is the expected rate of inflation at time t, P_t^t is the actual rate of inflation at time t, and Ω_{t-1} is the information available up to the previous period.[8]

Moreover, another key aspect of the New Classical model refers to the reinvigoration of the concept of 'continuous market clearing'. In a Walrasian fashion, this assumption stresses that at any given time, all markets are in equilibrium, with all observed outcomes being the result of the interplay between demand and supply responses to prices set by rational agents. All agents are price takers, unable to exert any sort of market power, and equilibrium is maintained either in short, or long, term. As opposed to Keynesian models, price adjustments are relatively rapid, raising many criticisms. One of the most important extension concerns that of the labor market (Lucas, 1978) for which the possibility of involuntary unemployment is excluded.

Within this competitive equilibrium framework, workers behave as utility maximizers, choosing the optimal combination of work and leisure. Firms are faced by the 'signal extraction problem' in their endeavor to distinguish between relative and absolute price changes. What their response to a rising price would be, depends on whether it refers to their products alone or to the general level of demand. In the first case, their response would be such, that they will try to boost their supply upwards. Hence, the "Lucas surprise function" can be expressed as: $Y_t = Y_{Nt} + a\left[\dot{P}_t - E\left(\dot{P}_t\middle|\Omega_{t-1}\right)\right] + \varepsilon_t$. This equation depicts that the distance between the actual (Y_t) and the natural level of output (Y_{Nt}) is determined by the difference between the actual rate of inflation ($\dot{P}_t$) and what is the rational expectation of it ($E\left(\dot{P}_t\middle|\Omega_{t-1}\right)$). What is more, the degree of influence is given by a, which shows the elasticity to an unanticipated change of prices (Lucas, 1973). From an empirical point of view, in developed countries with price stability, price changes are understood as being relative. Conversely, "in a stable price country like the United States … policies which increase nominal income tend to have a large initial effect on real

[8] Another representation is $P_t^e = P_t^t + \varepsilon_t$, where ε_t is a random error term with a mean of zero and is uncorrelated with the information set available at the time expectations are formed.

output, together with a small positive effect on the rate of inflation". The opposite holds for Argentina (Lucas, 1973, p. 332).

To avoid serial correlation in empirical investigation, the "surprise function" can be restated, incorporating a time lag: $Y_t = Y_{Nt} + a\left[\dot{P}_t - E\left(\dot{P}_t \middle| \Omega_{t-1}\right)\right] + \beta(Y_{t-1} - Y_{Nt-1})\varepsilon_t$. Assuming that the relation between output and unemployment follows the "Okun Law" (Okun, 1963) the latter can also be expressed as $\dot{P}_t = E\left(\dot{P}_t \middle| \Omega_{t-1}\right) - \varphi(U_t - U_{Nt})$, with U_t showing the actual rate of unemployment and the U_{Nt} denoting its *natural* equivalent.[9] Solving for U_t we get that $U_t = U_{Nt} - 1/\varphi\left[\dot{P}_t - E\left(\dot{P}_t \middle| \Omega_{t-1}\right)\right]$, which if carefully examined, it suggests that inflation surprises may result in reducing the natural rate of unemployment. To address the issue of how a real variable is analytically associated with a nominal one, Lucas resorts to this "surprise" effect as being responsible for provisionally annulling the idea of classical dichotomy (Gupta, Suraj, 1969).

Business cycles

Added to the above, the influence of Keynes' *General Theory* was also apparent on what the methodological grounds of studying the *business cycles* should be. Prior to the 1970s, scientific discourse on business cycles had been foreshadowed by Keynesians (and monetarists) focusing on the level of output as deviating from equilibrium. As long as the priority of the Keynesian theory was given to notions such as the multiplier, the business cycles were degraded as obsolete (Bronfenbrenner, 1969). Lucas' approach, on the other hand, has intended towards a redirection of the theory to capture the dynamic aspects of the economy and to depart from the *disequilibrating* ideas which were emphasized in Keynesian models. He sought to establish a relationship between the rate of change of nominal prices (inflation) and real output within a framework that would manage to address "money illusion". To achieve that, Lucas proposed a model where equilibrium prices and quantities exhibit a systematic relation between inflation and real output, akin to the Phillips curve, but derived within a Walrasian system of general equilibrium.

In Lucas's framework, monetary changes have real effects due to agents' inability to perfectly discriminate between monetary and real demand shifts, leading to no usable

[9] The unemployment consistent to equilibrium in the labour market, "the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is embedded in them the actual structural characteristics of the labor and commodity markets" (Friedman, 1968).

trade-off between inflation and real output. Business cycles are seen as serially correlated movements about the trend of real output, unrelated to the availability of production factors. Cyclical changes are understood as risks to be managed through the application of rational expectations. "Insofar as business cycles can be viewed as repeated instances of essentially similar events, it will be reasonable to treat agents as reacting to cyclical changes as 'risk', or to assume their expectations are rational, that they have fairly stable arrangements for collecting and processing information" (Lucas, 1977, p. 15).

The supply of output at any given time (Y_t) is comprised by a permanent component (Y_{Nt}) and a cyclical component (Y_{Ct}), such as $Y_t = Y_{Nt} + Y_{Ct}$. The former reflects the structural part of economic growth following the trend: $Y_{Nt} = \lambda + \phi_t$. The latter depends on the price surprise and on the deviations from the natural rate: $Y_{Ct} = a[P_t - E(P_t|\Omega_{t-1})] + \beta\ (Y_{t-1} - Y_{Nt-1})$. Combining these equations the aggregate supply relationship is written as follows:

$$Y_t = \lambda + \varphi_t + a[P_t - E(P_t|\Omega_{t-1})] + \beta\ (Y_{t-1} - Y_{Nt-1}) + \varepsilon_t$$

Agents respond rationally, but the outcome is non-optimal, due to the imperfect information (prices operate as signals) they have on what is the source of price-changes. Thus, the extent of the cyclical movement in output is based on the magnitude of the price variability attributed to the general level. For example, the more price changes are associated with variations at the general level, the lower the responses of output to monetary disturbances are going to be.

The real business cycle theory

The real business cycle (RBC) literature can be seen as the overplaying of equilibrium theorizing, one that actually paved the way for the restoration of the "Classical Model". As if the Keynesian thought had never set foot in the course of economic theory, the RBC trend paid no attention to the "common sense" needed for economic theorizing and developed its own thought consistent to the basic tenets of the presented model. Though its emergence can be explained as the natural extension or continuum of the "new classical" thought, RBC theorists seem to raise doubts on what the major sources of aggregate instability are and, moreover, on the essence of equilibrium itself! The paper of Kydland & Prescott (1982) inaugurated a new form and perspective of the classical ideas. The emphasis of explaining the cycles was given primarily to the supply side. Demand

shocks were left outside the scope of the RBC and the Walrasian type of equilibrium methodology was reinvigorated to incorporate all stages of the business cycle.

As we saw in the New Classical perspective, the idea of business cycles was not at all new. More than that, during the past, "real" cycle model had been described by several scholars (Ilut & Schneider 2014), focusing on investment expenditures and its impact on the supply-side. However, the Keynesian revolution of the post-war era contributed towards shifting the field of research to issues of macroeconomic performance, instead of fluctuations. Emphasis on the trend did not leave enough room for appreciating the explanation of the cyclical phenomenon. This view was challenged by Kydland & Prescott (1982) and (C. R. Nelson & Plosser, 1982) whose attention was given to real, rather than monetary, shocks to explain the trajectory of output. Hence, contrary to other mainstream theories viewing economic fluctuations as transitory phenomena, the RBC approach suggests that the effect on output may be permanent. Most of the times, RBC theory argues, output follows a 'random walk', showing no tendency to return to its trend after a shock. This can be shown as $Y_t = g_t + Y_{t-1} + z_t$,[10] with z_t symbolizing the shock. The most important implication of this finding by Nelson & Plosser (1982) is to be found on shocks attributed to productivity via technological changes.

The RBC models are built on the assumption of representative agents that are utility maximizers, forming rational expectations. The market prices are quite flexible and output fluctuations are led by random shocks in production technology. Moreover, initial impulses are endured by several kinds of propagation mechanisms – such as the time needed for investment to realize – and employment is voluntary. Lastly, money is neutral and there is no actual distinction between the long period and the short, since fluctuations and growth trend are integrated.

The production function – $Y_t = AF(K,L)$ – in RBC models has constant returns to scale, with A standing for total factor productivity or technology shocks, which depend on the previous level with a random parameter (ε): $A_{t+1} = \rho A_t + \varepsilon_{t+1}$, where $0<\rho<1$. In addition, agents behave as being utility maximizers, choosing between consumption (C) and leisure (Le), defined as the share of time available out of work ($Le=1-L$). The maximization

[10] The lagged variable has a 'unit-root', instead of a coefficient β, such as $0<\beta<1$, indicating a tendency to return to the previous path.

process concerns the discounted (β) value of expected utility for an infinite future time-horizon and individuals can substitute between consumption and leisure:

$$U_t = \max E_t\{\sum_{j=0}^{\infty} \beta^{t+j}\, u[C_{t+j}, 1 - L_{t-j}]|\Omega_t\}, 1 > \beta > 0.$$

The constraints subject to which utility is maximized are first, that consumption and investment cannot be greater than total output i.e., $C_t + I_t \leq A_t F(K_t, L_t)$ and second, that the time for labour and leisure comprise the whole time available to the individual i.e., $L_t + Le_t \leq 1$. Moreover, as it is usually the case, the current level of capital stock is determined by investment plus the remaining value of capital that has been left after depreciation is calculated: $K_{t+1} = (1 - \delta)K_t + I_t$.

An important issue is to consider the factors affecting the level of labor supplied. It is assumed that labour is valued on the grounds of its capacity to provide income, adequate for the individuals to improve their utility-based welfare through consumption. Thus, individual workers act so as their time is allocated between work and leisure. Their calculation is based on whether the real wage currently earned is taken to be higher or lower than the normal rate. In general, the higher the distance, the more the quantity of labour supplied. But, since the increased income makes people richer, this would also make them reduce the hours dedicated to labour. As a result, the final impact depends on the relative weight between the two opposite forces. In a nutshell, since the individuals' estimation is made in an intertemporal horizon, responses to real wage change as assumed large. Following the same line of argument, a raise in the real interest rate (*r*) today makes people increasing their supply of labour, since the value of present income in relation to that of tomorrow, increases. The "intertemporal relative price (*irp*)" signifies that the shocks affecting the real interest or the current real wage $(w/p)_c$ in relation to the future one $(w/p)_f$, result in increasing the labour supply.[11] For small changes to be associated with large impacts on employment, the labour supply schedule has to be highly elastic.

Lastly, the technological shock to which the RBC theorists alludes to, is approached through the idea of "Solow's residual". In the case of a Cobb-Douglas production function, we have that: $Y_t = A_t K_t^{\alpha} L_t^{(1-\alpha)}$, with A standing for total factor

[11] Hence, the *irp* can be expressed as $[(1+r)(w/p)_c] / (w/p)_f$.

productivity or the level of technology available. Converting into the logarithmic version, we take $lnY_t = lnA_t + \alpha lnK_t + (1-\alpha)lnL_t$ and, the first derivative gives that:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha\frac{\dot{K}}{K} + (1-\alpha)\frac{\dot{L}}{L} \Rightarrow$$

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - \left[\alpha\frac{\dot{K}}{K} + (1-\alpha)\frac{\dot{L}}{L}\right]$$

In that way, the RBC model focuses on the degree of variation of technology ($\frac{\dot{A}}{A}$,) as one of the most critical parameters for explaining aggregate fluctuations.

The New Keynesian approach to the macroeconomy

Up to a point, the emergence of the New Keynesian macroeconomic theory came as a consequence of the critique imposed by Lucas. The restorational strength of the classical ideas was to such an extent, that Lucas and Sargent envisioned economic life "after Keynes", proclaiming that "in the present decade [1970s], the U.S. economy has undergone its first major depression since the 1930s, to the accompaniment of inflation rates in excess of 10 percent per annum. These events have been transmitted to other advanced countries and in many cases have been amplified. These events did not arise from a reactionary reversion to outmoded 'classical' principles of tight money and balanced budgets. On the contrary, they were accompanied by massive government deficits and high rates of monetary expansion [promising] rapid real growth and low rates of unemployment" (Lucas & Sargent, 1979, p. 1).

However, the prevailed explanations to economic fluctuations did not persuade those who insisted on the need for coordinating the macroeconomy through the implementation of stabilization policies. "The co-ordination question, simply stated, is this: Will the market system 'automatically' co-ordinate economic activities? [...] I regard [this question] as the central and basic one in macroeconomics" (Leijonhufvud, 2000, p. 33). Afterall, during the following decades, one of the main issues that the Keynesians did care about its resolution, was centered around the high level of unemployment, documented during the 1980s and 90s. Apart from being theoretically consistent, the *new classical* and the *real business cycle* models with 'voluntary unemployment' may not be able to provide a persuasive explanation on how the rapidly increasing labour supply can be absorbed.

The New Keynesian trend of economic theory is not comprised by a set of homogeneous views. In general, the NK argue that markets are full of imperfections able to aggravate the real effects coming from nominal shocks. Moreover, another issue that gains widespread acceptance among the NKs, is that the role of fiscal policy in stabilizing the economy is debatable (Mankiw & Romer, 1991). The basic features of the orthodox Keynesian macroeconomics of the post-war period are also retained within the 'New Keynesian models'. Lack of regulation is expected to bring unemployment equilibrium, fluctuations are mainly caused by demand disturbances, money is non-neutral and governments should intervene for stabilization. However, in order to resolve the theoretical inconsistencies of the 'old' Keynesian theory, the New Keynesian approach resided in incorporating two additional characteristic aspects of the RBC. The first concerns the need for building macroeconomics upon micro-foundations and the second, the New Keynesian approach operates within a framework of general equilibrium analysis. With these two, the New Keynesians maintain that within this revised context, wage and price rigidities are better captured and that business cycles should be conceived as non-clearing state of markets. Following Lucas' critique, the New Keynesians were urged to theorize how the nominal rigidities can be explained from the agents' optimizing behavior. To do so, the majority of the New Keynesian models acknowledge the validity of the REH.

Nominal rigidities: For old and New Keynesians, price adjustments are slow. However, unlikely their predecessors, the NK do not take nominal wage and price rigidities by assumption, but they found them on micro-behavior. As in the New Classicals, they are assumed as being utility maximizers. However, due to the several price and wage rigidities that do not allow market clearing, the NK support their thesis of non-neutral money.

Nominal wage rigidities: The first aspect of rigidities concerns wage contracts. It is quite realistic to suppose that in the developed economies, the time-horizon of wage contracts is longer than that which is needed by monetary authorities to decide on changing the money supply and thus, inflation. Nominal wage rigidities can be incorporated within a Lucas surprise function, on the assumption that expected prices are formed through REH ($\dot{P}_t^e = E(\dot{P}_t|\Omega_{t-1})$) and that nominal wage increases are also linked with inflation ($\dot{W}_t = E(\dot{P}_t|\Omega_{t-1})$). Hence, total output is determined by $Y_t = Y_{\mathrm{Nt}} + a\left[\dot{P}_{\mathrm{t}} - \dot{W}_{\mathrm{t}}\right]$, ($a > 0$). Since changes in money supply occur more frequently, fixed wage lead to real changes in the short-run. Thus, monetary policy is not totally inefficient. Barro (1977) has posed critique

on the absence of solid microfoundations, able to explain the emergence of long-term contracts in the labour market.

Nominal price rigidities: In addition, the above logic may also lead us to support that an increase in the quantity of money, would be expected to employment positively, by lowering the real wage. This result, however, is not confirmed by empirical facts. Such criticisms paved the way for NK theory to explore the possibility of explaining fluctuations (Andersen, 1994). What distinguishes the NK from all others – old Keynesians, monetarists and New Classicals – is the important role they give to 'imperfect competition' which, as opposed to firms' operating under perfect competition, small changes in demand affect the level of firm profits. But if the firm is faced but a significant cost in changing its prices, then it may decide to abide to the same price as before.

Real rigidities: Romer (2019) explores a situation in which nominal changes may have significant real consequences. It can be maintained that a decreasing money supply with sticky prices, may lower the level of output. Moreover, if the supply of labour is inelastic, a fall in demand for labour will cause real wage reduction. Within a framework of monopolistic competition, firms faced with a positive sloping marginal cost curve will exhibit a strong tendency to decreasing their prices. This would probably let them overcome all obstacles to nominal adjustment required, but as the demand moves to the left (falls), the elasticity of demand decreases. Hence, a decreasing elasticity and output at a given price, means that the marginal revenue drops, and as a result, firms become unwilling towards reducing their prices.

A firm produces up to the point where marginal revenue (*mr*) equals marginal cost (*mc*), expressed as $mr=P+P(1/\eta)$, with η standing for the price elasticity of demand. Hence, at profit maximization it holds that $mc=P+P(1/\eta)$ and $(P-mc)/P = -1/\eta$. Restating the latter, can give us the mark-up equation $P=mc[1/(1+1/\eta)]$ and substituting the mc with its equivalent nominal wage over marginal product of labour, we get $P=(W/MP_L)[1/(1+1/\eta)]$. Within the squared brackets we get the mark-up which is inversely related to η. Thus, this last identity shows that a drop at the mc, will not necessarily bring the price level down, unless the mark-up would not change so as to counter-balance the effect. In periods of economic growth, the level of mark-up is expected to fall as the market become more competitive.

Business cycles: From a NK perspective, aggregate fluctuations are examined through the idea of nominal rigidities (G. Mankiw, 2022), and through the effects of wage-flexibility. In

the first case, a decline in the supply of money is expected to bring aggregate demand down, without any change in the price level due to several types of rigidities. However, employment exhibits a tendency to diminish, as the nominal wage remains constant. In that way, the demand shock can generate (involuntary) unemployment, a result which is interpreted as an incident of 'coordination failure' that could have been avoided, if firms would somehow decide to cut prices and increase their output.

Others, following Keynes' Chapter 19 of the *General Theory*, maintain that the wage-price flexibility cannot by itself secure output stability. A different approach is to assume firms may not be willing to undertake much risk. Stiglitz (1999) asserts that due to imperfections at the financial market, firms cannot cover their needs in financial assistance and become vulnerable as they are exposed to more debt instead of new equity. Such firms may prefer cutting down output rather than changing their prices and such a behavior is based on the idea that the probability of bankruptcy is positively related with the level of output. Hence, during a period of recession, the cost of bankruptcy of an additional unit of output increases and the entrepreneurs are reluctant to boost up their production during a period of receding demand. Following this train of thought, the level of prices remains unchanged, not because of some sort of frictions, but as the consequence of an embedded entrepreneurial behavior, when facing risk.

Apart from offering a general guideline to economic policy, the NK had to interpret the causes of high inflationary pressures. The 1970s have shown a tremendous increase in the general level of prices that required the implementation of relevant policies. The NAIRU concept determined the unemployment threshold above which inflation can be expected to decline. However, the rising rates of unemployment during the 1980s suggests that the NAIRU concept was needed revision as far as its determinants were concerned. For those economists supporting the New Classical views, the most important determinant responsible for this deviation from the conventional theory, was the low-level flexibility characterizing the labor market, that does not let the nominal wages to adjust (Ljungqvist & Sargent, 1998; 2008). The NK on the other hand, gave a different explanation, allowing for demand shocks to affect the natural rate. This led to exploring the possibility of path-dependent natural rate of unemployment. The current level of the natural rate of unemployment depends on the difference between the actual and the natural rate of the previous period such as $U_{Nt} = U_{Nt-1} + \alpha(U_{t-1} - U_{Nt-1})$. In case of a negative demand shock, output is expected to fall and unemployment to rise. However, when recession is over and the economy begins recovering, the unemployment does not

go back where it started but it settles at a different, possibly greater, level of natural rate. These thoughts have created several different strands of modelling inflation, such as the duration and the insider-outsider theories (Layard et al., 2005).

3. Heterodox approaches

Introducing a post-Keynesian theory of growth and distribution

While the mainstream models were evolving and changing in both ideas and forms, a different strand of economic theory and research was growing, step upon the Keynesian tradition. The ideas of Cambridge theorists, such as Nicholas Kaldor and Joan Robinson, were vividly fertilized and combined with other differentiated approaches, such that of Michał Kalecki and Luigi Pasinetti. Based on the classical political economy as well as in the *General Theory*, this branch of economist developed forming a multivariate group of economic school, with can called post-keynesians. According to Kurz & Salvadori (2010) the focal point of post-keynesian theories of growth and distribution, concerns the idea that savings are ultimately adjusted to investment.[12] Afterall, this is one of the most important features differentiating Keynes' ideas from the mainstream or 'classical' views on how modern economies operate. "The initial novelty [of the General Theory] lies in my maintaining that it is not the rate of interest, but the level of income which ensures equality between saving and investment" (Keynes, 1937, p. 250).

Kaldor has given much attention to this Keynesian redirection of the causal link between saving and investment and moreover, to the characteristic independence of the latter, influenced by the 'animal spirits' – Kaldor called it "Keynesian hypothesis" (Kaldor, 1955, p. 95). In the case of full capacity utilization and full-employment, savings are adjusted through the variation of prices relative to nominal wage, generating a distributional effect between the income classes. Moreover, in case of lower than full capacity of either capital or labour, savings are assumed to be adjusted through a changing of the degree of capital utilization or employment.

As has already been indicated, Keynes' analysis was contained to the short-run, within which investment changes affect the level of demand and production capacity remained unaltered. These attempts were following the Harrodian theory of economic growth, based on the idea of reformulating the theory of effective demand to be accommodated in the long-run. In Harrod's context, there is no reason to assume that the actual, natural and warranted rate will or should, be equated. Solow assumed an almost complete capital-labour substitution, so that the factors were adjusted according to

[12] See Commendatore et al., (2014).

changes in factor prices. Following the Harrodian notation, *v* was allowed to vary so that the "warranted" rate (the one with which the entrepreneurs satisfy their investment decisions) approaches the "natural" (that equals the population growth – and the changes in technology) through a Say's Law process in which savings operate as a leader to investment decisions.

According to Kaldor (and Joan Robinson), strong economic growth results in a redistribution from workers to capitalists, as the propensity of the former to save increases, facilitating the equalization of the warranted to the natural rate. In this approach, the Cambridge scholar preferred to think in a way of adjusting *s*, rather than *v*. Kaldor's initial approach to growth and distribution distinguishes between wage and profit earners, the former having a lower propensity for saving than the latter.[13] His savings function is thus: $S = s_w W + s_\pi \Pi$, which in the context of equilibrium gives $I = (s_\pi - s_w)\Pi + s_w Y$.[14] Investment is considered "net" and following the "Keynesian hypothesis" that *I/Y* should be treated as an independent variable, we get:

$$\frac{\Pi}{Y} = \frac{1}{s_\pi - s_w}\frac{I}{Y} - \frac{s_w}{s_\pi - s_w}$$

From this, the rate of profits (Π/K) is obtained by the latter, after it is multiplied by Y/K, which, Kaldor, assumed being constant in changes of distribution. Hence,

$$\frac{\Pi}{K} = \frac{1}{s_\pi - s_w}\frac{I}{K} - \frac{s_w}{s_\pi - s_w}\frac{Y}{K}$$

According to the latter expression, Kaldor concludes that *I/K* represents the rate of accumulation and that since *Y/K* is considered fairly constant by stylized facts, the rate of growth should equal the rate of capital accumulation. The profit rate "depends only on the rate of economic growth and the division of capitalists' income between consumption and savings, and is independent of everything else" (Kaldor, 1957, p. 613). In other words, $r = \Pi/K = g/s_\pi$, which has come to be known as the "Cambridge equation" (see Bortis, 1993).

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[13] This assumption was at first made on the grounds that the greater mass of profits was held as company profits with a major portion placed aside as "reserves" (Kaldor, 1955, p. 95). Afterwards, Kaldor indicated that the purpose of this assumption was mainly for indicating a situation in which profits were used for "self-financing", thus remained undistributed (Kaldor, 1966, p. 310).

[14] Since a closed economy ($Y=W+\Pi$) in equilibrium ($S = I$) is assumed, $W = Y - \Pi$ can be used so as S equals to $s_w(Y - \Pi) + s_\pi \Pi$.

During the 1930s, the relationship between the rate of profits and the rate of growth had also been examined by Kaldor. However, the influence of (Kalecki, 1942) and (Robinson, 1956) may be observed in that capital accumulation becomes the central determinant of growth. We can see that if we take $s_w=0$, the two equations above a converted into: $\frac{\Pi}{Y} = \frac{1}{s_\pi}\frac{I}{Y}$ and $\frac{\Pi}{K} = \frac{1}{s_\pi}\frac{I}{K}$ respectively. A closer look in these expressions may be seen as a vindication of Kalecki's "capitalists earn what they spent, and workers spend what they earn".

This new independent variable is given by the rate of accumulation (I/K) and $v=K/Y$. Harrod's first equation was based on that $G=I/K$, so that (after multiplying and dividing with Y), $Gv=I/Y$. The second equation of Harrod, could thus now be rewritten by Kaldor to reflect his own theoretical view of distribution, such as $\frac{I}{Y} = \frac{1}{s_\pi - s_w}\frac{\Pi}{Y} + s_w$. Hence, the warranted and the natural rates are related to each other, and the former will converge to the latter through changes in the Π/Y. However, according to Kaldor, this should not necessarily lead us to steady-state growth. However, excessive liquidity preference, could set an unduly high minimum for the profit rate on capital, which, due to uncertainty, it needs to surpass the interest rate. On the condition that the forces leading to such viciously recessionary pressures do not take place, Kaldor observes that "there will be an inherent tendency to growth and an inherent tendency to full employment. Indeed, the two are closely linked to each other" (Kaldor, 1955, p. 99).

Apart from the assumption of full employment, the previous framework performs under the idea of technical change. All changes were considered as caused by the varying capital-labor ratio and technical innovations or improved technologies were understood as being embodied in the quantities of capital. The fixed production function was thus, replaced by a new "technical progress function" in which the growth of labour productivity is associated with the growth of capital per worker. Hence, to revisit the previous "stylized" fact concerning the constancy of the K/Y ratio, Kaldor gives emphasis on that "the system will always tend towards the point where the growth in capital and the growth in productivity are equal" (Kaldor, 1957, p. 596).

A modern theory of Kaldorian growth

After some years of experimenting upon the notion of growth and distribution (King, 2010), Kaldor delivered a public speech on the "Causes of the slow rate of growth in the United

Kingdom", indicating a mature phase within which the UK had gone herself into. At that point, Kaldor starts differentiating the significance of the different sectors of the economy, highlighting the strong relationship between the growth of output and that of the manufacturing sector. Nevertheless, the high significance of increasing returns had previously been stressed from Alfred Marshall and more recently, by Allyn Young, who had primarily examined their dynamic character within a process of growth. One of the most influential explanations for this upscaling of the capacity to produce, was given by the accumulated feature of technical knowledge, learning and experience.

In general, Kaldor supported the idea that the theory of growth should be based on some generalized facts, empirically confirmed evidence which he called, "stylized facts" and which came to be known as "Kaldor's laws". Though some of them have already been mentioned, Thirlwall (1983) has made a condensed presentation of these "laws" which goes as follows: i) the growth of output is strongly connected with that of the manufacturing sector, ii) productivity rate of growth in manufacturing is linked with increasing returns to scale – Verdoorn's law (McCombie, 2002), iii) as the manufacturing productivity progresses, more labour is transferred to manufacture from other sectors, iv) manufacture growth is not constrained by labour supply shortages, but at its initial stage it is limited by demand from agriculture and at a later stage, by export constraints and v) a virtuous circle between output and exports is strongly associated with output growth and productivity growth. Obviously, according to Kaldor, the manufacturing sector is very important for growth (Thirlwall, 2013).

Let i=1, 2, 3 indicating the first, second and third law respectively, and j indicating the number of the coefficient. The first law says that the rate of output (g) is a function of manufacturing output growth (g_m) such as $g = b_{10} + b_{11}g_m$. Moreover, the second law is the "Verdoorn's law", where productivity of labour in manufacturing (q_m) is positively linked with manufacturing output growth (g_m), so that $q_m = b_{20} + b_{21}g_m$. Lastly, the overall growth of labour productivity is positively related with manufacturing output and employment growth, and negatively with employment growth in the rest of the non-manufacturing, sectors. Hence $q = b_{30} + b_{31}g_m$ and at the same time, $q = b_{32} + b_{33}\ell_m - b_{34}\ell_n$ (q is overall productivity and ℓ stands for employment growth).

Differences between ℓ_m and ℓ_n indicate the change in the economic structure. Kaldor's focus on structural change is based on the particular features characterizing the manufacturing sector. Labour productivity is usually higher than in all other sectors, the industrial sector shows a particular tendency towards increasing returns, these

industries have potentially strong backward and forward linkages and can cover the new domestic demand for industrial commodities which increases as the income grows (Szirmai, 2012).

Export-driven, demand led growth

In what follows, the analysis is centered around an open economy engaged in international trade. Kaldor has emphasized the importance of demand effects on the efficiency of the supply of goods. Verdoorn (1949) is understood as a restatement of Smith's old dictum of the relationship between the extent of the market and the division of labour, in a dynamically grown economy. Demand, on the other hand, is seen as being *relatively* autonomous, since its formation is based on the interplay between the extent of the market and division of labour, but the ultimate tempo, or the trajectory of growth is led by demand. Most particularly, that which comes from abroad, thus, exports. It wouldn't be an exaggeration to stress that the primary source of growth (g) resides on the rate of growth of real exports (x), through a dynamic foreign multiplier (k_x). Thus, $g = k_x x$.

Obviously, if this is true, the latter relationship implies that all growing economies should run surpluses in their balance of payments. However, Kaldor (1970) shows that this may not necessarily be true. Taking the structure of an open economy be described by the basic macroeconomic identities, we have that,

$Y = C + I + (X - M)$

$C = cY$

$I = a_1 \Delta Y = a_1 gY$

$M = vY$

Of the above, c, a_1 and v stand for the propensity to consume, capital-output ratio and the marginal propensity to import, respectively. A combination of those identities together, gives us:

$$Y = \frac{1}{1 - (c + a_1 g) + v} X$$

To show that export-led growth may be consistent with *balanced*-trade – not surplus – it can be assumed that $1 - c = \alpha_1 g$.[15] Accordingly, the latter is reduced to $Y = (1/v)X$ which is the Harrod foreign trade multiplier. Written in dynamic form, $\dot{M} = v\dot{Y}$ and $\dot{Y} = (1/v)\dot{X}$. The two combined, may lead to a simplified expression that $\dot{M} = \dot{X}$, suggesting that if the economy starts growing from a balanced position, equation between them is preserved. However, empirical work on the field of export-led growth has shown that countries trying to expand their share of exports in foreign markets are facing many challenges competing with others (Blecker & Razmi, 2010). Hence, from an empirical point of view, the previous outcome may seem to suffer by a fallacy of composition. Dixon and Thirlwall (1975) have expanded on Kaldorian export-led growth dynamics, based on a formal representation of a capitalist economy, described by

$g = k_x x$

$x = \varepsilon_x (\hat{P}_f - \hat{P}) + \eta_x g_f$

$\hat{P} = \widehat{W} - q$

$q = q_0 + \rho g$

$\hat{P}_f = \widehat{W}_f - q_f$

$q_f = q_0 + \rho_f g_f$

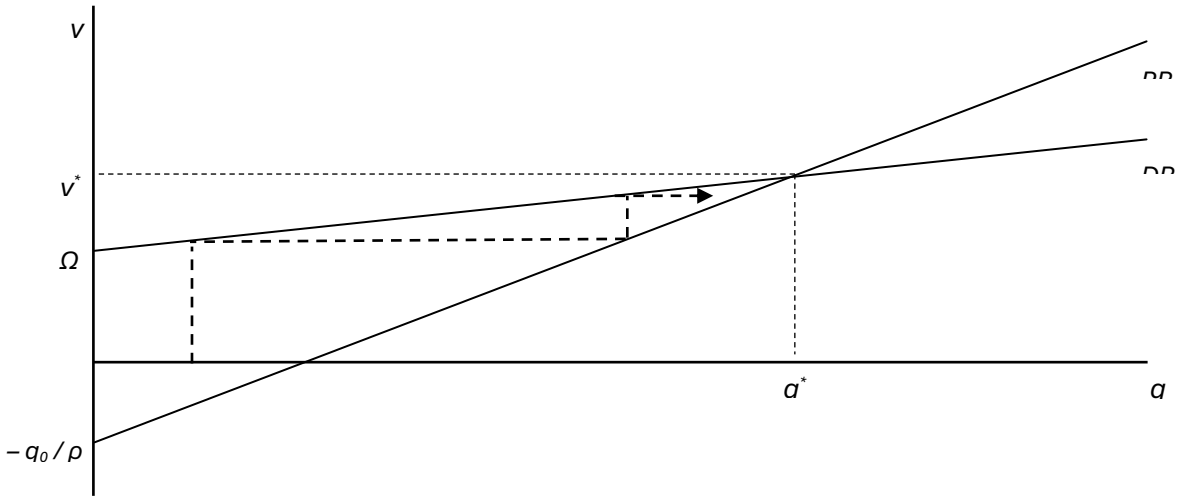
$\widehat{W}_f = \widehat{W}$

$\hat{P}$ stands for inflation, $\widehat{W}$ is the growth rate of nominal wages (another stylized fact of Kaldor, is that the long-run relative wage growths were assumed constant), q is the rate of productivity growth, $\varepsilon_x > 0$ represents the elasticity of demand for exports and the subscript *f* refers to anything defined as *foreign*. Equation *x* shows the growth rate of exports as a function of the price differential between domestic and foreign goods (rate of change of relative prices) along with the income growth rate of the rest of the world. It is generated as a derivation of the export demand function $X = X_0 \left(\frac{EP_f}{P}\right)^{\varepsilon_x} Y_f^{\eta_X}$, with E denoting the exchange rate, assumed as 1, for simplicity. The demand for exports is linked with the evolution of relative prices and the level of foreign income. $\hat{P}$ determines the level of prices, following the standard definition of unit labor cost as the ratio between nominal wage and productivity. Hence, $\hat{P}$ is mark-up pricing equation and the q is another expression for Verdoorn's law. In this last equation, q_0 exhibits the exogenous effects on productivity and ρ refers to the elasticity of productivity with respect to output

[15] This means that savings-income and investment income are equal or that the private sector balance is neither deficient, nor surplus.

– gives the extent to which, changes in output growth affect the rate of productivity growth.

Figure: The Kaldorian model as represented by a recursive process between productivity and demand



Combining equations *g* and *x*, we get $g = k_x(\varepsilon_x (\hat{P}_f - \hat{W} + q) + \eta_x g_f)$ which can also be simplified as follows: $g = \Omega + k_x\varepsilon_x q$.[16] According to Setterfield and Cornwall (2002), two regimes are discerned from equations above. The *productivity regime* is represented by the Verdoorn's law (q) and the *demand regime* by the last equation (g). These two, together, depicted in Figure, may be seen as representing the recursive interaction between demand and supply, in the process for growth rate determination. For $q = 0$, we get $g = -q_0/\rho$. Hence, the conditions for the above Figure to generate a meaningful narrative as moving towards a stable equilibrium (q^*, y^*) is that $\Omega > 0 > -q_0/\rho$ and, moreover, that $1/\rho > k_x\varepsilon_x$. As a result, *PR* is steeper than *DR*. Starting from $q < q^*$, the growth rate (*y*, depicted by DR) will cause a higher *q*, which in turn gives a greater growth rate and so on.

[16] Ω stands for k_x ($[\eta_x - \rho_f\varepsilon_x]g_f - \varepsilon_x q_0$). The part within the parenthesis can be written as $\eta_x g_f - \varepsilon_x(q_0 + \rho_f g_f)$. As it is obvious, this expression consists of two parts. The first part, designates the *positive* influence of foreign income growth on demand, also affected and directed by the income elasticity of demand for exports. The second part, reflects the *negative* influence of foreign income growth on demand, directed through the price elasticity of demand for exports (ε_x) and the elasticity of the foreign productivity to real output.

Thirlwall's law

The above analysis based on Kaldor's thought concerning export-led growth, does not take into account the important parameter of imports needed. As national income grows faster, there is nothing from stopping imports increasing in an ever-higher rate, causing a destabilized balance of payments. In line of this critique, Thirlwall (1979) has constructed a model that takes these restrictions into account. This come to be known as "balance-of-payments constrained growth model" or simply as "Thirlwall's law" and it is considered an extension of the Kaldorian "export-led" model of cumulative causation. "It may be possible to initiate a consumption-led, investment-led or government expenditure-led growth, for a short-time, but each of these components of demand has an import component. [...] If there are no export earnings to pay for the import content of other components of expenditure, demand will have to be constrained" (Thirlwall, 2002, p. 53).

The very essence of this theoretical approach is that a country's output growth is limited by its performance in the foreign markets and the way that financial markets respond. The foreign trade sets the limits to the extent of the market that is able to absorb the growing supply of commodities. "Most countries, apart from the oil producing countries of the Middle East, can absorb foreign exchange without difficulty; and most cannot earn enough. It is true, of course, that the world, cannot be BoP constrained, for all the rest to be so. There cannot be many less-developed countries that could not utilize resources more fully given the greater availability of foreign exchange" (Thirlwall & Hussain, 1982, p. 498).

These models maintain that the balance of payments is the most important long-run barrier to economic growth. Assume there are two goods, one produced domestically, the other imported by foreign market. Moreover, the supplies of both exports and imports are taken to be infinitely elastic. This simplifying assumption permits the conceptualization of a model where the quantities are determined solely by demand. Thus, using the mathematical form of constant elasticity, the export demand function is given by:

$$X = X_0 \left(\frac{EP_f}{P}\right)^{\varepsilon_X} Y_f^{\eta_X}$$

X represents exports, X_0 is a constant, E stands for the nominal exchange rate (calculated in domestic currency per unit of foreign currency), P_f is the foreign price level measured in foreign currency, P is domestic level of prices and ε_x is the price elasticity of demand

for exports. Y_f is the foreign income and η_x gives the income elasticity of the demand for exports.[17] The expression suggests that as the foreign goods becomes more expensive, may be unaffordable for the domestic incomes, but they also enhance the level of foreign demand. It can also be written as: $x = \varepsilon_x \left(\hat{E} + \hat{P}_f - P\right) + \eta_x g_f$.

In an analogous manner, the demand for imports is given by the following expression:

$$M = M_0 \left(\frac{EP_f}{P}\right)^{-\varepsilon_M} Y^{\eta_M}$$

M is the quantity of imports, *Y* is the level of domestic income, whereas ε_M and η_M symbolize the price and income elasticities of demand for imports, respectively. The latter implies that imports increase as the foreign goods become relatively cheaper and when domestic income rises. It can also be written as: $m = -\varepsilon_x \left(\hat{E} + \hat{P}_f - P\right) + \eta_M g$.

Moreover, the *balance* of payments suggests that $PX = EP_fM$ which, after some mathematical rearrangement, can also be written as $\hat{P} + x = \hat{E} + \hat{P}_f + m$. Replacing *x* and *m* from above, the latter gives:

$$(\varepsilon_x + \varepsilon_M - 1)\left(\hat{E} + \hat{P}_f - P\right) - \eta_M g + \eta_X g_f$$

In order for $\varepsilon_x + \varepsilon_M > 1$ Marshall-Lerner condition must hold, otherwise currency depreciation may not improve the balance of trade. If the income elasticities and the foreign income (g_f)are assumed to be given exogenously, adjustment is based on either *g* or *RER*, or in those two combined. Following the Keynesian tradition, Thirlwall assumes that income or output (*g*) is the basic adjustment variable. Hence, the most general expression of the growth of domestic income to maintain its balance of trade (g_b), takes the following form:

$$g_b = \frac{(\varepsilon_x + \varepsilon_M - 1)\left(\hat{E} + \hat{P}_f - P\right) + \eta_X y_f}{\eta_M}$$

In the latter, g_b is the "balanced of payments constrained growth rate". Furthermore, expanding on the Keynesian assumption that prices do not play a significant role in improving the trade balance i.e., $\varepsilon_x + \varepsilon_M \approx 1$, then the latter condition is simplified to

[17] Note that the ratio $\frac{EP_f}{P}$, is the "real exchange rate" (RER), showing how many domestic goods are needed for the purchase of foreign ones. As this ratio falls, domestic goods are relatively appreciated.

$$g_b = \frac{\eta_X g_f}{\eta_M}$$

In addition, irrespective of whether $\varepsilon_x + \varepsilon_M > 1$, the relation between domestic and foreign prices does not change in the long-run, we have that $\hat{E} + \hat{P}_f - P = 0$. Hence, the condition can also be rewritten as: $g_b = \frac{x}{\eta_M}$.

According to (Perraton, 2003), the latter is the *strong* form of the "Thirlwall's law", indicating that, assuming constant relative prices and balanced trade, a country's long run growth rate should be equal to the growth of its exports over its income elasticity for imports. It suggests that the sum of domestic private consumption, investment and government expenditures, should grow so that the balance of trade is maintained. Long-term or prolonged imbalances should be avoided for a country to follow a sustainable growth path.

Marxist theories of capitalist crises

Marxist theories of capitalist crises have a long history that goes back to the end of the 19th century. Apart from Marx's Capital, the issues concerning the causes of capitalist crises have been discussed extensively (Shaikh, 1978; Howard & King, 1992; Clarke, 1994). The Marxist literature offers a profound analysis of the intrinsic instabilities and contradictions, inherent in the capitalist mode of production. These views, embedded within the broader tradition of Marxist political economy, not only dissect the dynamics of economic downturns but also provide a predictive framework for understanding the cyclical nature of capitalist development (Sweezy, 1942/2016). At the heart of Marxist theory is the materialist conception of history, which posits that the economic base of society significantly shapes its entire structure, including social relations, institutions, and cultural norms (Resnick & Wolff, 1989). This perspective is crucial in understanding the nature of the capitalist mode of production, characterized by private ownership of the means of production and the pursuit of profit. Moreover, central to this analysis is Marx's labour theory of value (Ioannides & Mavroudeas, 2010; Fine & Saad-Filho, 2016) which asserts that the value of a commodity is determined by the socially necessary labor time required for its production. This theory underpins Marx's critique of capitalist exploitation and the generation of surplus value, forming the basis for understanding the contradictions leading to crises (Shaikh, 1998).

Marxist political economy articulates several theories through which crises are manifested, highlighting the systemic vulnerabilities of the capitalist mode of production (Fine et al., 2013). Marx identified *overproduction* as a fundamental contradiction in capitalism. The relentless drive for profit leads capitalists to produce goods beyond the market's capacity to consume, resulting in market gluts, falling prices, and economic recessions. What is more, Marx theorized that there is a tendency for the rate of profit to fall. This occurs because capitalists, in an attempt to outdo competitors, invest more in technology (constant capital) and relatively less in labour (variable capital), which is the source of surplus value. This leads to a decrease in the overall rate of profit, causing reduced investment, layoffs, and economic stagnation. However, throughout the 20th century, Marxist theories have focused on different causes, to explaining the volatility of fluctuations. These include the i) underconsumption theory, ii) the profit squeeze and iii) the Marxian law of the falling rate of profit.

The underconsumptionist theories give emphasis on the reduced level of the purchasing power in the economy as well as, on monopoly power. It argues that capitalist crises stem from the lack of effective demand for absorbing the goods produced, leading to an overaccumulation of unsold commodities. This theory emphasizes the distributional aspect of capitalism, where the working class, whose labor produces wealth, receives only a fraction of the total value of goods produced as wages. The disparity between the productive capacity of the economy and the limited consumption power of the masses leads to a situation where the market cannot absorb all the goods produced, resulting in inventory build-ups, cutbacks in production, layoffs, and a cyclical crisis of *overproduction* or *underconsumption*.

A branch of the above theory is the *Monthly Review* school. In the absence of any exogenous demand shock, the economies may found themselves in periods of prolonged stagnation (Sweezy et al., 2002). Financialization is seen as a systemic reaction, to arrest the inherent tendency towards stagnation and to circumvent the deficient level of aggregate demand.

The "profit squeeze" theory (Glyn & Sutcliffe, 1972; Boddy & Crotty, 1975) focuses on the pressure on profitability due to the increased strength of the working class as it is reflected in high net social wages (Maniatis & Passas, 2019; Missos, 2021) that reduce the profit share. According to this perspective, periods of economic prosperity and low unemployment, empower the demands of trade unions for higher wages and better working conditions. This empowerment of labor leads to a rise in the share of wages in

total income and a corresponding squeeze on profits. As the cost of labor increases, the surplus value that can be extracted by capitalists diminishes, leading to a decline in the rate of profit. This reduction in profitability discourages investment, leading to a slowdown in economic activity and potentially triggering a recession. Critics of the theory argue that capitalists can counter rising wages through technological advancements or by shifting investments to sectors with higher profitability, casting doubt on the sufficiency of the profit squeeze as a standalone explanation for capitalist crises.

Several other approaches can be placed under the aegis of the "profit squeeze". First, Wallerstein (2003) has given particular emphasis on the process of deruralization, as a cause for increased wages. Second, during the 1990s, the falling rate of profit was attributed to the role of international competition. The most notable work of this particular strand is Brenner (2006) whose explanation of the foreseeable recession was also followed by several observations concerning a subsequent phase of stagnation. Third, in a similar fashion, the "regulation school" focuses on the boundaries of particular technological stages of industrial capitalism, arguing that the productivity gains are gradually exhausted. On the condition that wages continue growing at the same pace as before, profits are expected to fall (Lipietz, 1986). Fourth, the Social Structures of Accumulation (SSA) school, underlines the importance of the "social accords" that have been brought about as a result of the labour's bargaining power, allowing for real wage to increase. Following the SSA, capitalist crises are the outcome of the dissolution of those "accords" or "contracts" (Bowles et al., 1989).

The Marxian law of the falling rate of profit refers to the inherent tendency of the rate of profit to decline in capitalist economies (Duménil & Lévy, 2004). This theoretical viewpoint, largely derives from Marx's work in the third volume of *Das Kapital* (Marx, 1998) and suggests that as capitalists invest more in constant capital and relatively less in variable capital (labour), the overall rate of profit develops a tendency towards decreases. A higher composition of machinery over labor leads to a decline in the generation of surplus value relative to the total capital invested. Although there are countervailing tendencies that may temporarily offset this decline, the theory asserts that the falling rate of profit is a fundamental contradiction of capitalism that leads to recurrent economic crises. Moreover, within the same framework, the relative or absolute changes of unproductive labour are examined, for explaining the insufficient level of value creation (Shaikh & Tonak, 1994; Mohun, 2005; Rotta, 2018).

A standard way of presenting the contrasting views on capitalist crises is to follow Weisskopf (1979). The rate of profit (r) is given by the ratio between the mass of profits (Π) and the stock of capital (K). Hence, $r = \Pi/K = (\Pi/Y)(Y/Z)(Z/K)$. In this last expression, Y stands for net output, Z for capacity output and $u=Y/Z$ measures the rate of capacity utilization.

Underconsumptionist views, stress the importance of low u as the main cause of falling profitability. If the effect of low demand is taken into account, the normal rate of profit $r_n = r/u = (\Pi/Y)(Z/K)$ may be constant or rising. Accordingly, the profit squeeze theory focuses on the fall of the Π/Y (or its corollary, the profit-wage ratio, Π/W), caused by the strong bargaining power of the trade unions, reflected in the increasingly contributing role of social protection in the disposable income. However, the falling rate of profit theory posits that its decrease is the consequence of a rising composition of capital K/Z – in value terms, it is written as c/v. Moreover, a rising ratio of unproductive (U) over productive (V) labor is the main driver leading to diminishing rate of profit, sufficient to out-balance any increase that may occur at the rate of exploitation (S/V). Thus, it is maintained that,

$$\Pi/W = (S - U)/(V+U) = (S/V - U/V) / (1+U/V)$$

Marxist theories of capitalist crises offer a profound and intricate critique of the capitalist system, highlighting its inherent contradictions and the inevitable cycles of crises it engenders. While not without its criticisms and challenges, the foundational premises of Marxist crisis theory—particularly its insights into overproduction, the falling rate of profit, capital concentration, and financial instability—remain highly relevant in analyzing the dynamics of modern capitalist economies. As capitalism continues to evolve, the insights provided by Marxist crisis theory will undoubtedly continue to serve as a valuable framework for understanding and critiquing the enduring instabilities and inequalities inherent in the system. As we grapple with the complexities of the 21st-century economic landscape, the perspectives offered by Marx on the nature and inevitability of capitalist crises offer a crucial lens through which to analyze, critique, and envision the future of our global economic system.

4. Equilibrium economics and the debate on econometrics

The relationship between the *General Theory* and equilibrium

For many decades, political economy has been marked by a gradual and steady ascend of mathematization and formalization of the past ideas (Weintraub, 2002; Milonakis, 2016; Missos, 2020). The growth theory that was permeated in the writings of the "Classical Political Economy" was reduced to mathematical equations and to the mechanics of equilibrium. For instance, Keynes, whose "influence is too obvious and pervasive to require comment" (Domar, 1957/1982, p. vii) was critical on the IS-LM equilibrium context of his theory. Undoubtedly, the publication of IS-LM opened one of the most prominent discourses on how economic theory ought to be modelled. Both theories of economic growth that had been inherited from the classical political economy, and from the neoclassical equilibrium tradition that were constructed especially after the formation of the IS-LM, went through a series of deep reconceptualization.

As these models were building up, a series of continuous and incessant efforts were followed, to calibrate and adjust these models to country-specific cases. Policy-oriented models and econometric techniques occupy a certain place in the history of economic ideas and are part of the Keynes-Tinbergen controversy of method and policy implications. Hence, the figure of Keynes is once more present, in this seminal debate, that left an indelible mark in the course of quantifying the effects of economic policies (Dhaene & Barten, 1989).

The method followed by the GT differs from that followed by the equilibrium framework. As it is well known, Keynes intended to show "what determines the volume of employment at any time" (Keynes, 1936, p. 313). Equilibrium analysis, on the other hand, shows what the values among variables must be for equilibrium to hold. Hence, the mainstream paradigm shows no strict causation between the variables, since they are simultaneously determined. But in Keynes, the variables are linked as causes and effects independent of equilibrium. For instance, "the propensity to consume and the rate of new investment determine the volume of employment" (Keynes, 1936, p. 30), should be read in the specific sequence given by Keynes and not as a set of parameters that can be related in any other way.

The tendency towards reducing Keynes' theory into equilibrium economics was apparent from a very early stage. A year after the publication of the GT the highly influential paper by Hicks (1937) entitled "Mr. Keynes and the Classics" appeared at Econometrica with a stated purpose to "isolate Mr. Keynes' innovations, and so to discover what are the real issues in dispute". To achieve his goal, Hicks went on indicating that "I assume that I am dealing with a short period in which the quantity of physical equipment … can be taken as fixed". Hence, long-term growth was out of scope. Did Hicks succeeded in squeezing the juice out of Keynes, or in his endeavor to achieve a condensed version of essential features, several important aspects were missed? Did Robinson go too far by calling the contributions based on this tradition as "bastard" (Robinson, 1975, p. 128).

As a first impression, Keynes' way of thinking may seem to be close to that of the IS-LM. The independent variables used in the GT were "(1) The three fundamental psychological factors, namely, the psychological propensity to consume, the psychological attitude to liquidity and the psychological expectation of future yield from capital-assets; (2) the wage-unit as determined by the bargains reached between employers and employed; and (3) the quantity of money as determined by the action of the central bank" (Keynes, 1936, p. 246). Hence, the framework within which Keynes' theory operates is quite different since the variables are not simultaneously determined. In the short period, investment decisions are taken by the entrepreneurs who are being committed to follow and cannot be changed during the period.

On some occasions, the level of investment actually made may be more or less than the level actually required to maintain full employment. Accordingly, the process begins by assuming the marginal efficiency of capital and the rate of interest that would determine investment. Following that, the consumption will also be determined by the multiplier which would eventually sum up to aggregate demand. The latter, along with the aggregate supply, are going to define the level of employment, output, price and income. Hence, unintended investment may lead to revising future expectations downwards, that may further affect income in the following period. On that issue, though, the period was considered as long enough to desired levels of investment and consumption to adjust to actual ones. Then, after the determination of income, by combining that with the stock of money and the liquidity preference function, we get the rate of interest. Equilibrium requires that the rate of interest is equal to that in the previous period. A higher (lower) interest rate would bring lower (higher) investment in the following period. Thus, the GT actually shows that the level of employment is determined by that of effective demand

and not by the equation of wage with marginal disutility. Accordingly, “the volume of employment is given by the point of intersection between the aggregate demand function and the aggregate supply function [...] the point [...] called effective demand [...] this is the substance of the General Theory of employment” (Keynes, 1936, p. 25).

Instead of describing an economy in equilibrium, Keynes insisted on emphasizing what determines the level of employment and output independently of the state of the economy. By saying that the GT is “a study of the forces which determine changes in the scale of output and employment as a whole”, Keynes actually indicates that his work should not be understood as a system of simultaneous equations. Macroeconomic forecasting models have been the subject of intense scrutiny, particularly following their failure to predict the 2008 financial crisis. These models, including the widely used dynamic stochastic general equilibrium (DSGE) approaches, often fall short in capturing the complexities of socioeconomic affairs. Critics argue that the simplified assumptions underpinning such models make them ill-equipped to foresee large-scale economic disruptions, highlighting significant limitations in their application to real-world scenarios (Krugman 2012). While DSGE models have been praised for their predictive power in certain contexts (Edge et al. 2010), their performance during periods of recession or recovery remains questionable. The validation of these models often relies on data sets that include periods of high average volatility, that obscures their inadequacies in times of extreme economic shocks (Wieland et al. 2012). Such reliance on historical data that assumes relatively stable conditions undermines their ability to predict irregular events, like crises.

Krugman (2012) identifies three key features that limit the applicability of DSGE models to predict crises. First, these models are complex and produce results that are difficult for non-specialists to interpret. Second, they are not well-suited to addressing large uncertainty shocks, as they are designed to handle normal, random variations rather than abrupt crises. Third, their reliance on tractable modeling methods often involves linearity or linear approximations, which diminishes their ability to capture the nonlinear dynamics typically associated with severe economic crises. Consequently, DSGE models struggle to provide reliable predictions during periods of sudden and significant economic turmoil, which often involve multiple equilibrium points and heightened complexity.

Tinbergen's pioneering work on econometrics

During the same period in which the *IS-LM* model was developing, a set of different ideas were also confronted with aspects of Keynesian authority. Jan Tinbergen, the distinguished first recipient of the 1969 Nobel Prize in Economics (jointly with Ragnar Frisch), emerged as a monumental figure in the annals of 20th century economic scholarship (Hansen, 1969). According to Dekker (2021), Tinbergen's legacy lies in his pioneering conception of how to conduct economic policy and to his contributing role in establishing the legitimacy of economic expertise as a vital instrument for state governance and planning.

During his youth, Tinbergen was engaged with socialist ideology – though he was critical to the labor theory of value – which were later channeled into pragmatic avenues through his active participation in the Dutch plan-socialist movement during the 1930s. Econometrics was viewed as equipping the economist with the necessary tools for socialist *interventions* in the economy aimed at reducing cyclical fluctuations and poverty (Magnus & Morgan, 1987, pp. 118–119; Knoester & Wellink, 1993, p. 19). The explanatory power of the proposed equations was notably high, with his R^2 values generally surpassing 0.98 (Epstein, 1987, p. 33). Among others who held a similar perspective on econometrics but who were facing persecution due to their socialist beliefs were, Lawrence Klein and Harold Hotelling expressed support for market socialism (Arrow, 1990, p. 107). Moreover, Ragnar Frisch was also inclined towards socialism, as recounted by Tinbergen (Blaug, 1998, p. 67).

The first econometric techniques were approached as tools that were designed to interpret and explain economic fluctuations. The main aim was to provide policies for stabilization and during the first post-war years, the policymakers became economic decision makers (Dekker, 2021, p. 222). Tinbergen was thus, primarily, a policy-economist rather than an academic theorist. As opposed to the views expressed by other economists, the main question for Tinbergen was the generation of some simple abstract relations and how the economy should be reformed in order to become stable and predictable. In this strand of thought, two aspects are taken into account. First, the institutional framework of the economy under consideration has to be unchanged

(*ordnung*) and secondly, one needs to set some feasible targets ahead, to have some sense of planning.[18]

The econometric techniques used and developed by Tinbergen stand out as a seminal attempt in the evolution of economic analysis. His intention to integrate statistical business cycle with quantitative methods was a first critical step towards forging a pathway for measuring the relationships among economic phenomena. The heart of this method lies on the objective to identify the direct causal relations posited by economic theories, employing regression analysis, or what Tinbergen termed, "correlation analysis". By 1936, the year Tinbergen presented his first model, the Netherlands had not shown any sign of recovery from the 1929 crisis. Its international trade had plummeted to a third of its past level, severely affecting its historical, export-led growth pattern. The economic situation was even more exacerbated by the Dutch adherence to the gold standard, which it had rejoined in 1925. Efforts to manage currency overvaluation involved painful adjustments, including deflation, low wages, and low costs.

Within this historical context, the main theme of the 1936 annual meeting held by the *Dutch Association for Economics and Statistics*, where Tinbergen made a presentation of his model, he revolved around the way towards economic recovery, with or without government intervention and irrespective of changes in export levels. Obviously, the central subject of the meeting underscored the pressing need for the application of efficient economic policies to address the ongoing economic slump. Tinbergen's model was groundbreaking in its use of empirical data to analyze and predict the effects of various economic policies, setting a precedent for policy-oriented economic modeling. His approach involved considering several policy scenarios, including a three-year investment program, import limitations on consumer goods, labor productivity improvements, price reductions, wage rate adjustments, and currency devaluation while accounting for potential foreign reprisals. No doubt, the application of mathematical modelling to policy analysis was a novel concept at the time and a pioneering effort. The development of the Tinbergen model was based on the emerging econometric techniques guiding policy decisions and marked a significant shift towards the empirical justification of the impacts of policy decisions.

[18] This he endeavored as a chief economist of the *Dutch Central Planning Bureau* between 1945-'55.

The Tinbergen model was relatively small, comprised of 24 equations, but it was quite complex for its time. The model distinguished between different social groups (labor and others), types of goods (consumer and investment goods), uses for non-labor income (consumption and saving), reflecting a sophisticated understanding of economic dynamics. The model addressed both the domestic economy and its interactions with the international environment, treating certain variables as exogenous (such as world price levels and the volume of world exports) and others as endogenous. It lacked government-related variables, monetary, and financial variables, focusing instead on the real sector.

What is more, the model included various equations for prices, quantities, and nominal values, each designed to reflect different economic relationships and dynamics. For example, equations for the daily wage rate, cost of living, and prices of production means are specified to capture cost and demand dynamics. The structural equations encompass relationships like the wage formation equation, which linked wage rates to employment and prices, so that the wage dynamics are linked to the economic conditions. The construction of the model reflects an effort to capture business cycle dynamics, with a trend represented in many equations to account for long-run developments. The absence of government, monetary, and financial variables indicate the specific focus and limitations, constraints imposed by the available data as well as, on the economic understanding of the time.

The debate with Keynes

Tinbergen did not start his academic career as an economist. The change from physics was partly motivated by the devastating effects that the 1929 Great Depression had on society, especially concentrating his efforts on the problem of high unemployment (Tinbergen, 1984, p. 315). Unlike the United States, where the impact was immediate and severe, the Dutch economy experienced a delayed and prolonged downturn. This period was marked by his innovative development of economic models aimed at mitigating the adverse effects of the economic downturn. In the aftermath of World War II, his contributions in macro-econometric modelling (Welfe, 2013, pp. 9–13) evolved into a comprehensive technique of how economic policy ought to be conducted. This framework not only offered a durable foundation for formulating economic policy worldwide but also ensured and promoted the institutionalization of economic expertise.

From 1936 to 1938, Jan Tinbergen held the position of economic analyst at the *League of Nations* at Geneva, where he was at the forefront of applying statistical methods to economic research, particularly emphasizing the analysis of the business cycles. This groundbreaking work ignited a notable methodological debate with John Maynard Keynes. In his critique of Tinbergen's approach to econometric methods, specifically tailored for the analysis of business cycles, Keynes offered his insights writing:

> "No one could be more frank, more painstaking, more free from subjective bias or *parti pris* than Professor Tinbergen. There is no one, therefore, so far as human qualities go, whom it would be safer to trust with black magic. That there is anyone I would trust with it at the present stage or that this brand of statistical alchemy is ripe to become a branch of science, I am not yet persuaded. But Newton, Boyle and Locke all played with alchemy. So let him continue." (Keynes, 1940, p. 156).

His subtle irony, likened to treating the matter playfully, and his concluding remark, resonates as a tacit nod of parental endorsement towards childlike antics. Obviously, he was not content with the method's merits.

Keynes' initial objection did not refer to the validity of regression analysis as such, but it was particularly concentrated upon the nature of "economic material", as the latter being subject to changes imposed by the element of time. In a letter to Royall Tyler,[19] Keynes replied that this approach, is more suitable for application to "the action of numerically measurable, independent forces [...] on material constant and homogeneous through time". The estimated coefficients, on the other hand, are supposed to remain invariant over time and "there is no reason at all why they should not be different every year" (Keynes, 1973, p. 286). According to this viewpoint, Tinbergen could not encompass other, non-numerical, though important, factors and was also unable to take into account the effects of those numerical ones which, for any reason, did not vary substantially throughout the period under consideration.

Moreover, Tinbergen's initial contribution was accused as being *atheoretical* (Koopmans, 1947), driven by the statical data. From his perspective, this methodological preference was motivated by the conviction that although statistical tests are incapable of confirming whether a theory is correct, they at least can reveal its inadequacies by

[19] Royall (Peter) Tyler was an historian, economist and diplomat who, among other highly profiled posts, served as a financial advisor and economic expert of the League of Nations. After receiving a draft of Tinbergen's analysis, he sent it to Keynes asking for comments.

demonstrating its failure to account for specific facts. Underpinning this statistical endeavor was the acknowledgement of economic theory, which provided a necessary justification of the causal relationships being tested. Tinbergen asserted that the prior validity of the theoretical basis was imperative for the reliability of the econometric application. One should begin "from the principle that economic theory should tell what the variables to be included are, and if one requires that lags shall be reasonable and the signs of the coefficients in accordance with economic theory" (Tinbergen to Keynes, 1973, p. 292).

To conclude, according to Dekker (2021, pp. 226–230), discussions on planning during the 1930s had not yielded definitive outcomes, leaving the concept of planning quite open to debate. Tinbergen admired public works, especially as a response to economic downturns, yet the broader framework of modern economic policy remained undefined. It was acknowledged that economic corrections could be made through strategic responses to external shocks, employing "policy shocks" to counteract them, with public works cited as a reactive measure that did not address systemic issues.

In addition, the challenge of addressing system lags, often a result of prolonged production cycles or delayed reactions, was not addressed. Many proposed stabilization policies risked increasing economic inflexibility, thereby accentuating the significance of lags. Such suggestions to modify coefficients were speculative at best, hinting at Tinbergen's broader aspiration for structural economic reform rather than mere adjustments to existing variables. This ambition far exceeded the scope of conventional Keynesian anti-cyclical measures, focusing instead on transformative change.

Opting for a political consultancy role, Tinbergen gathered close colleagues from the 1930s who shared his transformative vision.[20] This assembly, marked by vibrant enthusiasm and a unified set of economic ideas, comprised a new wave of social scientists committed to societal improvement through rational strategies. The average age of the staff was just above thirty years old, signaling a dynamic, forward-thinking environment. However, despite the collective zeal and shared goals, the *Central Planning Bureau* functioned as a policy institution, distinct from an academic hub, staffed by

[20] This includes Ed van Cleeff, H. Stuvel, Johannes Petrus Verdoorn, and Johan Witteveen, to whom he was a mentor.

promising Dutch economists rather than a diverse international cohort as seen in other international institutions.[21]

[21] The work of Jan Tinbergen underscores the importance of economic planning as a necessary and pragmatic response to the historical circumstances of his time. Tinbergen argued that the disruptive events of the early 20th century – such as the devastating impact of the two World Wars, the global economic turmoil following the Great Depression of 1929, and the spread of revolutionary ideas emanating from the Soviet Union – created a compelling case for adopting planning as a central tool for economic recovery and development. In his view, these historical pressures demanded organized and systematic approaches to managing economies, moving beyond laissez-faire policies to prevent future crises and ensure stability and growth (Tinbergen, 1964, p.5).

5. The years of economic planning

During the postwar decades, economic planning emerged as a dominant paradigm in mainstream economic thought, often described as the "political religion" of the era (Judt, 2010, p.67). This widespread embrace of planning reflected a consensus that laissez-faire economics had been rendered obsolete by the economic crises of the early 20th century and the global challenges posed by war and reconstruction. Mazower, for instance, highlights this shift, observing that postwar politics operated on the premise that the debate was no longer about choosing between planning and laissez-faire but rather about distinguishing between effective and ineffective planning (Mazower, 2000, p. 204). Similarly, Hobsbawm (1995, p. 272) notes that policymakers, officials, and even many business leaders in the postwar West rejected the notion of a return to unrestricted free markets, favoring state intervention and planning as essential tools for ensuring economic stability and growth.

The rise of economic planning was deeply rooted in the historical realities of the time. The devastations of the First and Second World Wars demonstrated the necessity of centralized coordination to mobilize resources effectively, while the Great Depression of 1929 underscored the failures of unregulated markets. This context gave rise to various planning frameworks, from the centralized mechanisms of *Gosplan* in the Soviet Union to the interventionist policies of the *New Deal* in the United States and the *Zentralplanung* of the Nazi-era. Despite their significant impact, these models have often been studied in isolation, leaving their broader historical and theoretical interconnections underexplored. A systematic investigation of their evolution would illuminate not only their individual contributions but also the shared economic and political imperatives that shaped them, offering insights into how societies have historically grappled with the balance between state control and market freedom.

In the 1950s and 1960s, many poor and developing countries embraced economic planning as a strategy to accelerate growth and modernize their economies. Emerging from the shadow of colonial rule and World War II, these nations faced widespread poverty, underdeveloped infrastructure, and limited industrial capacity. Economic planning provided a framework for governments to take a central role in directing resources and investments toward key sectors. Inspired by the successes of state-led industrialization in the Soviet Union and guided by developmental economics, these

countries sought to address structural weaknesses by prioritizing state-driven investment in social overhead capital such as transportation, energy, education, and healthcare.

The State was a pivotal driver of economic transformation during this period, channeling significant resources into the construction of infrastructure. Large-scale investments in roads, railways, dams, and power plants were seen as prerequisites for industrialization, as these projects created the conditions necessary for private sector activity to flourish. Governments also established public enterprises to manage and operate critical industries, such as steel, energy, and telecommunications, which were often deemed too risky or capital-intensive for the nascent private sectors. In nations like India, five-year plans became blueprints for economic progress, emphasizing not only industrial development but also the expansion of basic services to uplift rural populations and reduce regional disparities.

Social overhead capital played a dual role in fostering economic development. First, it addressed immediate needs by creating employment and stimulating domestic demand. Second, it laid the foundation for long-term growth by enabling the productive activities of future generations. While the State's intervention often achieved significant strides in infrastructure and social services, the centralized approach also faced challenges. Inefficiencies, misallocation of resources, and corruption, limited the effectiveness of planning in some contexts. Nonetheless, the emphasis on state-driven investments in social overhead capital during the 1950s and 1960s set the stage for many developing countries to build the institutional and physical frameworks necessary for eventual economic transformation and integration into global markets.

Economic planning in Greece from 1950s

In the aftermath of the World War II, the Greek economy was left in a state of severe disrepair. Public infrastructure lay in ruins, essential facilities were destroyed, and the country's productive capacity was significantly reduced, if not in impasse. At this time, Greece was characterized as an underdeveloped economy, heavily reliant on development aid from the USA (Kofas, 1989). The Greek economy had a significantly lower level of production, than its potential and a damaged monetary system, unable to sustain a market economy. Establishing a trustworthy credit system was very difficult to achieve under the circumstances. Among other serious problems associated with the lack of funds, the reluctance of the first governments to raise fiscal revenues through

direct taxation of the speculative incomes, made the Greek economy to rely heavily on the external aid.

Amidst these challenging socio-economic conditions, the establishment of the *Centre of Planning and Economic Research* (KEPE)[22] was envisioned as a means to explore development prospects for the Greek economy and to create a dedicated institution for addressing the foremost challenges the country was facing. It was tasked with responding to the pressing structural and persistent issues of the Greek economy, particularly concerning its balance of payments. Moreover, its mandate included the preparation of short to mid-term "development plans" (Pagoulatos, 2003) and providing technical support as well as evidence-based advice to public institutions and the government. The period that extends from 1947 to 1957 can be understood as the beginning of planning in Greece. The first economic plans of the Greek economy were conducted in a rush and without any substantial scientific assistance and institutional infrastructure. Throughout these periods, four programmes were conducted:

a. The reconstruction plan of the Greek economy, 1947
b. The provisional long-term plan of economic recovery, 1948-1952
c. The plan of economic development, 1952-1956
d. The 3-year plan of economic development of 1953.

A closer examination of the aforementioned plans for economic development and growth reveals some key conclusions about their general character, aims, and scope. The primary objective of these strategies was to integrate Greece into the emerging international division of labor that was taking shape in the post-war years. Achieving this goal necessitated a series of essential investments in social overhead capital, including ports, bridges, dams, and reclamation projects. These large-scale infrastructure projects were envisioned to provide the economy with a "big push," a positive shock needed to restart economic activity and address pressing issues such as underemployment, unemployment, and socioeconomic distress. Another significant aim of these plans was

[22] Throughout the years, the *Centre* has been abbreviated as KEPE, to resemble the Greek abbreviation i.e., ΚΕΠΕ. To address the economic challenges of the time, the *Committee for Research and Organization of Economic Planning* was established in 1957. This was followed two years later by the *Centre of Economic Research*, which was eventually succeeded by the KEPE in 1961.

to set Greece on a sustainable growth trajectory by addressing persistent structural problems, such as chronic deficits in the current account. However, the potential impact of these programs on foreign currency reserves led Greek administrative offices to abandon their implementation efforts. As Sakkas (1996, p. 44) argues, these programs can be more accurately described as a form of wishful thinking rather than scientifically grounded plans. Their prospects for realization were limited due to a lack of necessary funding and the absence of detailed cost estimations required for realistic, risk-assessed investment strategies.

A similar discussion to that of the preceding period took place during the intermediate years between 1957 and 1961, when the accession of Greece to the European Common Market was validated. As the US development Aid began to phase out, the prospects for sustained economic growth were undermined, given that increases in national income had largely depended on external subsidies. Efforts to address structural imbalances were often perceived as attempts to destabilize the political system, resulting in the continuation of policies that perpetuated these issues. In addition to its research activities, KEPE was entrusted with preparing five-year economic development plans, signaling a shift toward systematic planning. The establishment of these institutions, alongside the gradual development of their operational frameworks, represented an effort to revitalize the process of economic planning. Their aim was to provide scientific, evidence-based analyses supported by empirical data and national account statistics, reflecting the methodological advancements of the 1960s. To achieve this, young domestic economists working within these institutions were joined by experienced researchers and international academics, whose expertise in economic planning contributed significantly to their efforts.

Several notable figures played pivotal roles in guiding Greece's economic planning during this period. Pasquale Saraceno, an Italian structuralist known for his pragmatic approach to economic policymaking, supervised the 1960–64 economic plan (Rotondi, 2019). Wilfred Beckerman, a central figure in indicative planning for developing countries, contributed to the 1968–72 economic plan (Beckerman, 1974; 1978; 1992; 1993; Balassa, 1990). Bela Balassa, an expert on economic integration, assisted with the 1978–82 economic plan (Balassa, 1962). Lastly, two economic experts from the United Nations, Thomas Vietoritz and Richard Lissak, provided their expertise for the 1983–87 program (Vietoritz, 1983).

Macro-models for Greece

Macroeconomic models for the Greek economy during the 1960s and 1970s were largely shaped by Keynesian principles, deemed particularly appropriate for small, developing nations. Reflecting the prevailing trends of the period, these models prioritized the concept of "effective demand" (Klein, 1947). Early macroeconomic models for less developed economies drew extensively from the simplified Keynesian frameworks that had gained traction in more advanced countries during the 1940s and 1950s (Klein, 1965). However, by the 1980s, the focus shifted toward understanding the monetary side of the economic structure and its integration into macro policymaking (Karapapas, 1987).

Many early models concentrated on the real sector's supply and demand dynamics but overlooked the role of the monetary sector, a significant limitation. Consequently, several demand-driven models exhibited overly simplified structures (Suits, 1964; Adelman & Chenery, 1966; Pavlopoulos, 1966; Scheidell & Tsoublekas, 1974). Among these, Suits' model (1964) was notably detailed and based on more sophisticated economic assumptions but still suffered from critical shortcomings (Prodromidis, 1971). In addition, demand-oriented models incorporating the multiplier-accelerator principle were later developed by Deimezis (1984), Paleologos (1984), Prodromidis (1986), and Sallas et al. (1988).

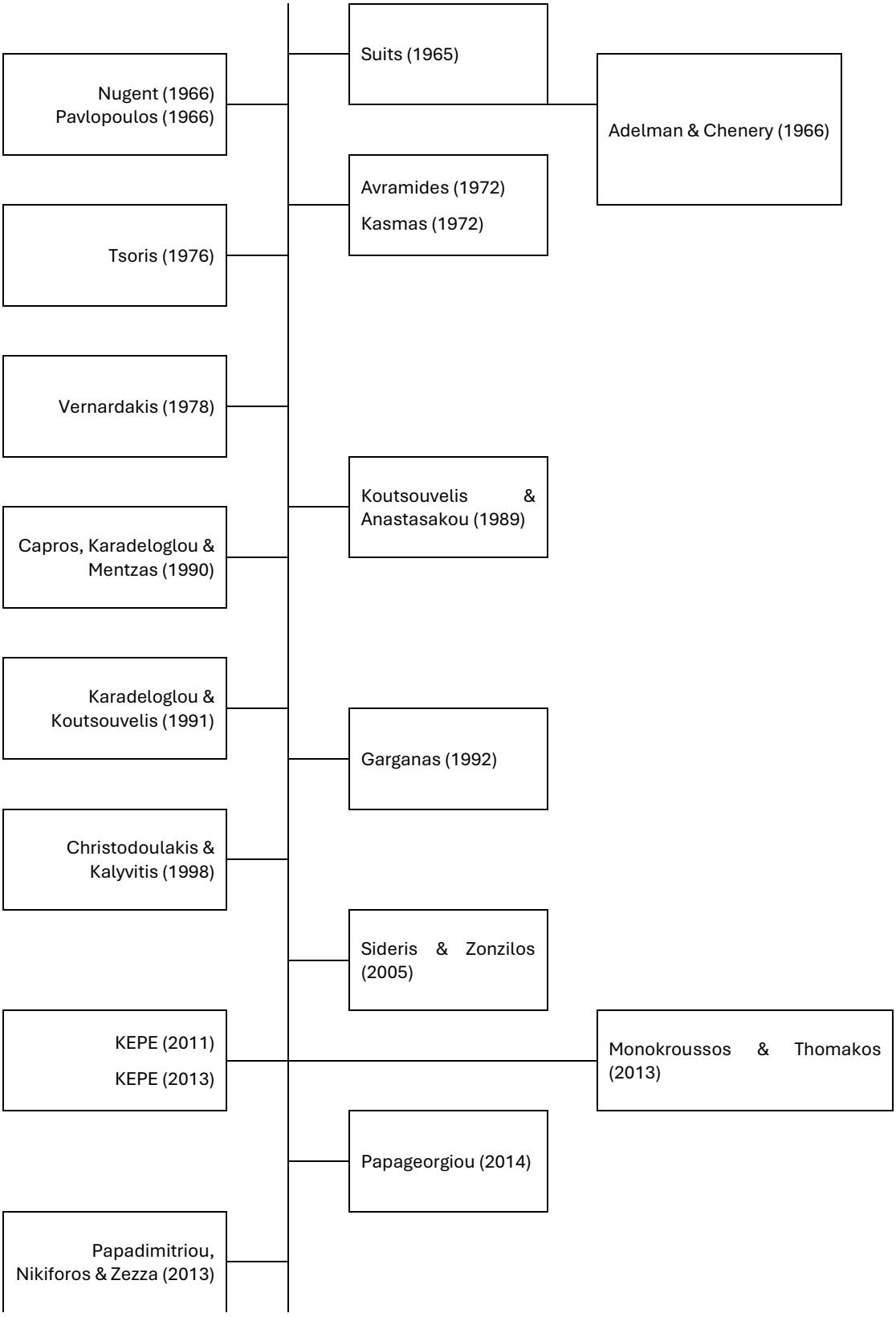
As macroeconomic modeling evolved, some frameworks began incorporating both demand- and supply-side components. Tsoris (1976) and Vernadakis (1978) introduced production functions, disaggregating economic output into sectors such as agriculture, manufacturing, construction, mining, and services. These efforts paved the way for models that integrated the monetary and real sectors. Notably, Kasmas (1972) and Avramides (1972) developed approaches based on the monetary base's sources and uses. Later, Katos (1979) introduced a growth model rooted in the Keynesian income-expenditure framework, incorporating factors such as population growth and technological progress. These advancements reflected the increasing sophistication and depth of macroeconomic modeling in addressing Greece's economic challenges.

to develop and interconnect a suite of macroeconomic, multi-sectoral models tailored to European economies (Alcantara and Italianer, 1982). The responsibility for designing HERMES model for Greece was assigned to KEPE (Koutsouvelis and Anastassakou, 1989). This was a detailed model, which divided the economy into nine sectors, estimated

variables such as production, investment goods demand, exports, imports, final and intermediate goods prices, wage formation, and energy production. To determine the demand for capital, labor, and energy, it utilized sectoral constant elasticity of substitution (CES) production functions. However, significant gaps were evident, since the model did not account for capital accumulation, neglected stock-flow interactions concerning private wealth, and excluded public sector dynamics entirely.

Another noteworthy contribution came from Capros, Karadeloglou, and Mentzas (1990), who developed a model for the National Technical University of Athens (NTUA). This approach adopted a new Keynesian framework, where equilibrium in supply and demand resulted from simultaneous adjustments in quantities and prices. Covering sectors like agriculture, mining, manufacturing, energy, and services, the model was complex, incorporating 320 dynamic and nonlinear equations. Endogenous variables included production, employment, foreign trade, wages, and prices. Despite its advancements, the inability of this model to account for the monetary sector and its treatment of government activities as exogenous are considered as significant drawbacks

Figure 1: Chronological order of the literature of the main models proposed for the case of the Grek economy



During the early 1980s the European Commission introduced the Harmonised European Research Macrosectoral Energy System (HERMES) initiative, aiming

Moreover, in evaluating the impact of the Community Support Framework I (CSF I) program (Georgiou, 1999), which spanned the years 1989–1993, significant advancements were made, including the works of Lolos and Zonzilos (1992) and Bourguignon, Lolos, Suwa-Eisenmann, and Zonzilos (1992). Their main aim was to focus on the impact that the development projects of the EU would have on Greece. In a similar manner, Christodoulakis and Kalyvitis (1998, 2001) constructed a model aimed at assessing the potential effects of CSF II for the next period (1994–1999). The macroeconomic modeling landscape was further refined, drew from the HERMIN framework – an evolution of HERMES that had been applied in Ireland (Bradley, Whelan, and Wright, 1995), Portugal (Modesto and Neves, 1995), and Spain (Herce and Sosvilla-Rivero, 1995). Christodoulakis and Kalyvitis (2001) expanded the scope, by managing to incorporate 40 behavioral equations, 42 identities, and 17 exogenous variables. The inclusion of previously neglected sectors – such as those producing tradable and non-tradable goods, public services, and agriculture – marked a key advancement. Furthermore, to enhance its analytical capacity, public infrastructure, human capital formation, supply-side externalities, inflation processes, and wage dynamics were also integrated.

Zografakis (1997) also contributed to these developments through the creation of Computable General Equilibrium (CGE) models. Following Johansen (1960), Zografakis used a Social Accounting Matrix derived from the 1988 input-output table and national accounts to construct a neoclassical CGE. Dividing the economy into 12 production sectors and 15 branches, the model assessed how economic policies influenced income distribution and examined the impacts of significant immigration into Greece during the 1980s (Zografakis and Sarris, 1999). Although aggregate macroeconomic models are often used for economic forecasting, those developed early on for Greece by KEPE (Karadeloglou and Koutsouvelis, 1991) and the Bank of Greece (BoG) (see Garganas, 1992) faced challenges that prevented their systematic application for regular forecasting and policy simulation. These challenges included an inability to account for changes in indirect tax rates or commodity price shocks and a failure to analyze the industry-level effects of shifts in final demand.

Part of the broader LINK project, which interconnected models from various nations, was the KEPE model, MYKL. With 110 equations, the MYKL model addressed variables such

as private consumption, investment, foreign trade, employment, wages, and prices. Exogenous variables like public investment, government consumption, and external debt were also included. However, decisions by the public and private sectors were not influenced by factors such as the accumulation of public debt, private wealth, or external liabilities.

Meanwhile, the BGEM model developed by the Bank of Greece (Garganas, 1992) showcased demand-driven features alongside supply-side considerations. Incorporating the monetary sector, especially the credit market, the BGEM model examined interactions involving government debt, financial assets, and capital stock. Variables such as private consumption, investment, and trade flows were treated as endogenous, while public expenditure, investments, and interest rates were exogenous. By emphasizing these interactions, the BGEM model provided a more comprehensive understanding of the structural dynamics shaping the Greek economy.

6. The models of the Greek economy

Suits' econometric model at KEPE (1965)

In the early 1960s, Daniel Suits of the University of Michigan, an expert in quantitative economics specialized in applying econometric methods, was appointed by KEPE to conduct a study on the Greek economy. His work is one of the first attempts of estimating an econometric model for the case of Greece. "The construction of an econometric model is [...] a continuing process in which successively more and better information is incorporated in steadily improving approximations of economic reality" (Suits, 1964, p. 131). His work focuses on the period between 1951 to 1961 and it is a pioneering attempt to determine quantitative relations between basic macroeconomic variables. Following the model developed by Suits (1962) for the US economy, a structural model for short-term macroeconomic forecasting is adjusted by estimating 35 equations based on these short time-series. Six equations refer to consumer demand, six to demand for imports, eight to investment demand, eight to production and income and seven are associated with taxes. All estimations processes follow a simple OLS technique, and the work presented is both informative and educational.

Suits embarks on a tiresome and painstaking technical work for adapting the relations between several key variables on available data. The exact choice of those variables examined has been made on the basis of their quality and has taken under consideration the general situation that existed in Greece at the time the study was written. Undoubtedly, the undertaken task was quite ambitious.

The variables are distinguished in four groups. *Endogenous*, such as the disposable income and consumption, that are determined by the model. *Quasi-predetermined*, such as the fixed investment which are calculated by the past outcomes, and which should be replaced by surveys. *Predetermined*, like capital stocks, which are historically given and lastly, *exogenous* variables, such as agricultural production, "whose values are fixed by public policy, nature, weather conditions and other noneconomic factors" (Suits, 1964, p. 104).

The first six equations refer to private consumption expenditure, each associated with a particular consumption category (food, tobacco, clothing and footwear, durable goods and household appliances, housing and other services). Moreover, each of these

categories is examined along several combinations of other variables such as, disposable income, a lagged version of the dependent variable, relative prices and the level of bank deposits (represented by bank reserves). Among the different combinations of variables, the researcher chooses the equation-forms that are statistically significant. Among the findings of this first series of equations, some observations may be worth noting. First, the coefficient of demand for food is quite high, but indicative of an economy which dedicates more than half of its disposable income to this category. Second, Suits (1964, p. 39) argues that according to the evidence, the coefficient for services seems to be unexpectedly high. Moreover, the total marginal propensity to consume (determined as the sum of the specific coefficients of demand estimated for each category) is 0.63, which is more or less, at the same level as in other western economies. Following the same pattern of inquiry, in Chapter III, Suits examines the demand for imports. The first result estimated is quite important for the Greek economy. The coefficient for demand for capital imports on industrial value added is very high, 0.695. The demand for agricultural products and for luxury products does not give statistically significant results. However, as a primary and a less credible results, the overall marginal propensity of the Greek economy to import in relation to the disposable income is estimated to be quite high, at 0.23.

In chapter IV, eight additional equations are examined for each category of private investment (agriculture, manufacturing, transportation, mining, services and housing). Investments in stock of industrial goods (ΔS_m) are determined as a function of the current value added in manufacture (G_{mt}) as well as, of the stock of the previous year (S_{mt-1}). Given that the desired level of stock should be $S^*_m=kG^*_m$, the equation that gives the inventory accumulation can be written as $\Delta S_m=h(kG^*_m - S_{mt-1})$ hence, $\Delta S_m=hkG^*_m - hS_{mt-1}$. The latter generates results that are more or less anticipated, but statistically insignificant. As a result, k = 0.38, meaning that the estimated "stock of manufactured commodities is about one-third of value added at annual rates" (p. 58).

Keynesian influences appear in commenting on the dynamic character with which private fixed capital expenditures were specified. For each sector, Suits employs the notion that current investment is determined by the sector's activity in the previous period and the value of plants already installed. The first part may be viewed as a proxy of profitability and when seen as a ratio to the value of stock, it gives the level of efficiency. However, data availability issues in the value of stock led Suits to substitute them with the accumulation of past investment, concluding that current expenditure is not related to

current activity. “The observed investment behavior was dominated by psychological and other noneconomic factors”. (p. 61).

In Chapters V and VI, the necessity for an input-output table for the Greek economy is stressed to transform market demand into production categories. Gross National Product is taken to be the sum of consumption, trade balance, investment and government expenditure while, Personal Income is the GNP minus depreciation and indirect taxes. It is estimated that more than half of indirect taxes are provided by import duties. The study indicates that within the decade, the social transfers as a percentage of nonagricultural GNP was increasing.

In conclusion, this study estimates the simple Keynesian multipliers for each variable on the total output of the Greek economy. Among the various results presented, some are particularly noteworthy. It is remarkable that the fixed investment multiplier is less than one, reflecting the low level of industrialization in Greece. For economies at a lower stage of industrialization, increasing fixed capital leads to a sharp increase in imports. “Indeed, a substantial part of the machinery and equipment installed in any Greek factory must be directly imported, and even to the extent that these items are domestically manufactured, their production requires a substantial component of imported materials” (Suits, 1964, p. 120). Additionally, the study highlights a crucial aspect related to tourism, emphasizing the sector's impact on the balance of payments. An increase of one billion in tourism expenditure boosted total consumption by 1.48 billion. However, this increase is mitigated by 0.3 billion spent on imports. A similar rationale applies to the exports multiplier, which shows that a rise in exports of 1 billion is partially counterbalanced by 0.3 billion of imports, thus diminishing the net foreign exchange gains.

Nugent’s optimal development programming (1966)

In 1966, Jeffrey Nugent, a professor of economics at the University of California (USA), published a seminal study in KEPE on determining Greece’s comparative advantage amidst rapid development (Nugent, 1966). This study aimed to create a model that was beneficial for resource allocation and for assessing the efficacy of implemented policies within the broader narrative of the country's economic evolution. Notably, in 1961, Greece entered into an association agreement with the European Economic Community, integrating into a free trade area. The prevailing viewpoint supporting this move (towards a customs union) highlighted two major anticipated benefits: Greece would gain access

to significant EEC developmental financial aid, and the demand for its exports, particularly tobacco – a highly valued and profitable commodity in Greek trade – would be secured by other member states (Lambert, 1961). Therefore, the author initiates his analysis with a caution, stating, “Greece has only a limited time period in which to reallocate its resources in such a way that it can survive and hopefully prosper within the Common Market” (Nugent, 1966, p. 17).

Given the current economic climate in Greece, it is clear that the domestic market does not conform to the ideal of a *free market*. Domestic economic activities lack competitiveness, and technology is widely inefficient to a significant extent. In this context, strategic planning emerges as a viable alternative that, when executed effectively, could mitigate existing disparities and uncertainties in resource allocation. Nugent argues that such planning must prioritize economic development's critical driver: investment. The targeted allocation of scarce capital to various sectors through “investment planning” is seen as a key strategy for harmonizing the private sector. Overall, this approach positions the analysis at the intersection of two predominant economic policy perspectives i.e., the advocacy for a free market versus the endorsement of planning.

A significant portion of this study is dedicated to introducing “linear programming” as a method for economic planning. The historical context of the Greek economy is deemed crucial in this analysis. Nugent points out that by 1950, Greece teetered on the brink of collapse. A notable migration of the population in the years following the end of the civil war, a loss or severe damage to productive capacity, soaring inflation, and critical external balance challenges – mitigated only through strict capital controls and import restrictions – characterized this period. By 1954, these issues began to wane, and by 1961, Greece had achieved notable growth rates. Despite this recovery, a spectrum of other serious problems persisted, set to remain for decades. Industrial growth was tepid, protected by high tariffs, while construction experienced a boom. However, this was not the type of investment necessary to enhance the country’s productive capabilities. Furthermore, much of this construction activity was disproportionately concentrated in Athens, with little benefit trickling down to the lower income brackets. During these initial postwar years, exports stagnated while imports steadily increased. Remarkably, unemployment remained relatively low, attributed to the population’s propensity to emigrate. Nugent, however, cautions that the short-term unemployment relief from emigration must be

balanced against the long-term impact of the young population's exodus on the country's entrepreneurial potential.

The most important conclusion of the study is that, according to Nugent, Greece is confronted with balance of payments problems the allocation of capital between 1954 and 1961 was far from optimal. Greece's comparative advantage is located in agriculture and some specific manufacturing activities, such as textiles, chemicals metals and transportation products, whereas import substitution policies seem to be preferable to export expansion.

Pavlopoulos' statistical model for the Greek economy (1966)

In 1966, Pavlopoulos, who was later served as the deputy director at KEPE from 1971 to 1973, published a revised edition of his doctoral dissertation originally completed at the University of Manchester. His primary objective was to conduct a comprehensive analysis of the Greek economy, which was groundbreaking for its time. Despite being the third publication on the subject, this book represented the first econometric exploration specifically focusing on Greece. The macroeconomic model Pavlopoulos developed includes 17 linear equations, analyzing four key sectors: private consumption, private fixed investment, imports, and agricultural production stock. Eight of these equations delve into detailed areas such as consumption, plant and equipment investment, imports, residential housing investment, agricultural and non-agricultural income, and price formation. Additionally, two equations link revenues to direct and indirect taxes, while the remaining seven are defined as identities, based on specific economic definitions.

This is an "effective demand" model with little emphasis on the side of production. Agricultural product, being very important for Greece, is the only aspect of production given direct attention and investment is considered as part of income. Moreover, the capital markets (or the monetary side of the economy) are not incorporated. Be that as it may, throughout his research, Pavlopoulos encountered significant challenges in data collection. The lack of available wage and employment data was particularly problematic, leading to notable, albeit necessary, omissions in the model. These gaps resulted in the inability to accurately determine the production function or analyze labor demand. Hence labor is almost totally ignored. The absence of this crucial data underscores the broader difficulties faced by economists working on econometric

models for economies with less developed statistical systems. Pavlopoulos's work, therefore, not only shed light on the Greek economy's structure and dynamics but also highlighted the critical importance of robust economic data collection for effective policy analysis and planning.

The pioneering effort paved the way for subsequent economic research in Greece, setting a foundational benchmark for the use of econometrics in analyzing and understanding the complexities of national economies. His work remains a testament to the challenges and potential of applying rigorous quantitative methods to economic problems, particularly in settings where data limitations are prevalent. This study not only contributes to the academic understanding of the Greek economy but also serves as an educational cornerstone for future economists and policymakers aiming to navigate the intricate interplay of economic variables in a continuously evolving global landscape.

As in previous studies, the critical juncture of the historical period is acknowledged. He adds that Greece needs to "advance quite rapidly in the years ahead in order to improve its competitiveness and to increase thus the probability of her survival within the Common Market, in view of the gradual elimination of tariff protection provided by the Treaty of Athens and the big gap that exists today between Greece and her partners in the Community in terms of productivity and competitiveness" (Pavlopoulos, 1966, p. 2).

The model is derived using both OLS and two-stage OLS methodologies. Selection of results is based on the significance of regression coefficients, residual autocorrelation, and the ability of these estimated equations to account for observed changes in economic variables. Predominantly, the model overlooks supply-side adjustments and omits any examination of sectoral dynamics within the Greek economy. Its focus lies nearly solely on the deficiencies of effective demand, while structural issues within the economy are notably absent from the discussion. The author posits that the monetary stability achieved between 1953 and 1955 was a step in the right direction. However, regarding the balance of payments, the author suggests that the current state of equilibrium is precarious, relying on "invisible" financial inflows such as remittances and other incomes. "The latter may be considered as the most sensitive element if the balance of payments in relation to international instability and therefore is not a sufficiently reliable source for external payments" (Pavlopoulos, 1966, p. 24).

Despite these criticisms, the book has several strengths, particularly the educational value of Chapter 6 on econometrics. Within Chapter 4, among other analyses, it assesses

the impact of multipliers, with the negative effect of exports on GNP emerging as perhaps the most surprising, or even seemingly illogical, finding. Nevertheless, the study stands out as a significant effort to support policymakers in devising and implementing economic strategies.

Adelman and Chenery

The econometric model developed by Adelman and Chenery (1966) for Greece in their is a prominent example of a developmental economic framework aimed at understanding how foreign aid contributes to economic growth and structural transformation. While it incorporates Keynesian elements, such as demand-side variables and equilibrium conditions, its focus on structural change, sectoral dynamics, and long-term development places it squarely within the developmentalist school of thought.

The core structure of the model includes key equations representing the primary relationships between macroeconomic aggregates:

GDP Identity: $GDP = C + I + G + (X-M)$

where C is private and public consumption, *I* is gross investment, *G* is government expenditure, X represents exports, and M is imports.

Consumption Function: $C = c_0 + c_1 Y_d$

Here, *C* depends on disposable income (Y_d), with c_0 representing autonomous consumption and c_1 denoting the marginal propensity to consume.

Investment Function: $I = I_0 + I_1 \Delta GDP$

Investment is modeled as a function of autonomous investment (I_0) and induced investment proportional to changes in *GDP* (*ΔGDP*).

Savings-Investment Balance: $S=I$

Savings (*S*) must equal investment (*I*), ensuring macroeconomic equilibrium.

Balance of Payments Equation: $(X-M) + K = 0$

The trade balance (*X−M*) is offset by foreign capital inflows (*K*), including foreign aid and external loans.

Government Budget Constraint: $G = T + B$

Government expenditures (*G*) are financed through tax revenues (*T*) and borrowing (*B*).

These equations are integrated into a system to simulate the interaction of foreign aid, domestic savings, investment, and trade balances within Greece's economy. The model disaggregates components like private and public consumption, residential and non-residential construction, and imports and exports to provide granular insights into economic dynamics.

The model is innovative for its time, as it integrates macroeconomic aggregates with sectoral disaggregation, moving towards a more detailed analysis of economic performance during a critical period of post-war reconstruction and growth. By disaggregating consumption, investment, and trade components, it provides granular insights into the interplay between foreign aid and domestic economic structures. The inclusion of foreign aid as a central variable highlights its developmental focus, emphasizing the role of external financial inflows in stabilizing the economy and addressing structural bottlenecks.

The work by Adelman and Chenery (1966) underscores the importance of diversifying investment into high-productivity sectors like manufacturing to enhance export capacity and reduce trade deficits. By identifying inefficiencies in resource allocation – such as the excessive focus on construction – the model offers actionable recommendations for improving economic performance. On the other hand, the model does not go without limitations. Like many models of its era, it assumes linear relationships and constant coefficients, which may oversimplify the complexities of an evolving economy. For example, it does not fully capture the informal sector or dynamic changes in technology and productivity. On top of that, it pays relatively less attention to institutional and governance factors, which are critical for effective resource allocation and policy implementation.

In general, the model draws on Keynesian ideas, particularly in its treatment of macroeconomic equilibrium conditions and the role of aggregate demand in driving growth. However, its emphasis on foreign aid, structural transformation, and sectoral investment reflects the developmentalist tradition. This school of thought, influenced by figures like Rosenstein-Rodan, Nurkse, and Prebisch, advocates for state intervention and coordinated investment to overcome market failures and foster industrialization in developing economies. Adelman and Chenery's work also aligns with the dual-economy models of Lewis and Kuznets, which highlight the transition from traditional, low-productivity sectors to modern, high-productivity industries as a hallmark of development. Their model's focus on shifting resources to manufacturing and exports

resonates with these ideas, underscoring the importance of structural change for sustainable growth.

The model demonstrates that foreign aid was instrumental in stabilizing Greece's post-war economy, financing critical investments, and achieving growth rates of approximately 6% annually by 1961. However, the findings also reveal inefficiencies in resource allocation, with excessive investment in construction limiting productivity gains. The authors recommend diversifying investment into manufacturing and export-oriented activities, which would enhance competitiveness and reduce trade deficits. Adelman and Chenery (1966) highlight the importance of institutional capacity and strategic planning in utilizing external resources effectively. Their model offers valuable lessons for contemporary policymakers in developing countries, emphasizing the need for a balanced approach that integrates external aid with domestic reforms and structural transformation.

The model by remains a seminal contribution to developmental economics, providing a comprehensive framework for analyzing the interplay between foreign aid and economic growth. While it reflects the Keynesian emphasis on demand-side dynamics, its developmental focus and sectoral disaggregation set it apart as a pioneering effort in modeling the structural challenges of a post-war economy. Its insights into resource allocation, sectoral priorities, and the role of foreign aid continue to inform economic policy in developing contexts, demonstrating the enduring relevance of its methodology and conclusions.

Econometric studies of Greece (1976)

The econometric research conducted by Nicholas Tsoris (1976) builds upon his doctoral thesis submitted to the University of Lancaster in 1975[23] and subsequent work at KEPE. The primary objective of his model is to support economic planning and generate reliable predictions for five-year plans. The theoretical foundation of the model is rooted in the IS-LM framework, encompassing three main sectors: fiscal, monetary, and real.

The fiscal sector is analyzed through a detailed examination of government revenue structures, modeled using 36 equations and identities designed to forecast revenue composition. Tsoris develops a personal income tax liability function for policy analysis

[23] Supervisors were T.D. Nguyen and A. El-Mokadem.

purposes. In the monetary sector, he employs mainstream financial market theories, assuming households and businesses diversify their portfolios and act rationally to maximize the expected utility of their wealth. The demand for financial assets is adjusted to actual magnitudes, and there is no assumption of money illusion. The money supply is modeled in a simplified manner, relying on the fraction of currency held by the public, the ratio of bank reserves to deposits, and the monetary base.

The real sector includes components such as private consumption, investment, a production function, exports, and imports. The model's microeconomic units – households, firms, and the government – interact within individual markets where relative prices are determined. However, Tsoris highlights that free market dynamics alone may not ensure optimal welfare outcomes. Achieving objectives such as full employment, low inflation, balanced payments, and increasing GDP per capita may require active government intervention through instruments like taxes, social insurance contributions, and exchange rate adjustments. The proposed model for Greece comprises four sectors, with sectoral output calculated using a Cobb-Douglas production function, incorporating the sum of sectoral values and income from abroad. Initially, two models were developed, one containing 90 equations and identities and the other 91. In Model I, the implicit deflator of private consumption is determined by a price-setting equation, which is then used to explain the implicit deflator of GNP. In Model II, variations in GNP at current prices are modeled as a function of exogenously determined changes in the money supply.

The demand for labor follows a Keynesian perspective, with entrepreneurs basing hiring decisions on expected output levels and real wages. Tsoris employs advanced econometric techniques, including the Taylor expansion to linearize non-linear equations and the Two-Stage Least Squares method for estimations. The robustness of the models is confirmed using the Theil inequality index, which validates the fit between predicted and actualized values. While Models I and II adopt a supply-side approach, deriving output and income from production functions, Model III focuses on simulations for the five-year plan (1977–1981). In this model, output is linked to an increasing capital-output ratio.

Finally, in Chapter 9, Tsoris addresses persistent challenges facing the Greek economy, particularly the balance of payments. He identifies this issue as a significant obstacle to future growth. To mitigate this constraint, simulations are conducted using a modified structure in Model IV, reallocating investment from construction to manufacturing. Overall, Tsoris (1976) represents an impressive and pioneering effort to establish a solid

foundation for economic modeling in Greece, offering valuable insights into the complexities of economic planning and forecasting.

Econometric models for the developing economies (1978)

Nikos Vernardakis[24] (1978) extends his critique of the econometric techniques of the 1970s, particularly their application to less developed economies like Greece. He highlights several structural characteristics of such economies: the agricultural sector constitutes a relatively larger share of the total product; manufacturing is dominated by small-scale production units; investment decisions are less influenced by interest rates compared to developed financial markets; exports are significantly lower than imports; emigration outflows are frequent; unemployment and underemployment persist as pressing issues requiring policy intervention; and income distribution remains highly unequal. Such features can also describe Greece.

The model Vernardakis proposed comprises 32 equations, including 11 identities, 19 behavioral equations, and 2 institutional equations. To the best of our knowledge, this model is the first to attempt a comprehensive analysis of income generation in the Greek economy. Recognizing that the central issue of the Greek economy lies in its insufficient productive capacity, the model emphasizes the supply side. It incorporates a neoclassical production function for the modern (manufacturing) sector and a "capacity to produce" framework for the traditional (agricultural) sector. The service sector is represented through a demand equation. Together, these three components determine the overall level of output, from which income and demand are derived. This approach deviates from Keynesian models, which focus on identifying employment levels

[24] Born an raised in Egypt, Nikos Vernardakis pursued higher education at Cornell University (USA), earning a BA cum laude, an MA, and a PhD in Economics. He worked as a Financial Consultant in the executive offices of Mobil Oil and G.R. Grace in New York and later joined the International Monetary Fund (IMF) in Washington, D.C., as a staff member. After the post-independence period, Vernardakis returned to Greece and took up roles at the Bank of Greece (as a researcher) and the KEPE. He also served as a Special Advisor to the Ministry of Finance and was a member of the Council of Economic Experts. At the University of Patras, where he is a faculty member, Vernardakis taught courses including Economics of Technology, Strategic Management of Technology, International Economic Relations, and Macroeconomic Theory. He held the Jean Monnet Chair at the University and has acted as an Objective Reviewer for Greek proposals under the "Delors' Package" on behalf of the European Communities. He has participated in various European Union committees. During his tenure at the University of Patras, he served as Department Chair for nine years – first in the Department of Economics and later in the Department of Business Administration. He has been a director of the Laboratory for Innovation, Development, Transfer, and Knowledge Management. His extensive research portfolio includes participation in several projects, many of which were funded by European programs. See: https://www.blod.gr/speakers/bernardakis-nikos/

compatible with existing demand. Instead, Vernardakis's model assumes an abundance of labor.

On the expenditure side, consumption is disaggregated into durables (explained by income distribution), non-durables, and services. The model includes three equations for imports (investment goods, consumer goods, and materials) and five equations for investment, categorized by sector: agriculture, mining, manufacturing, dwellings, and services. In the modern sector, investment is determined by capital stock, output, and the level of investment in the previous period. One notable peculiarity of the model is its treatment of population growth and capital stock, which are not directly linked to private investment in dwellings. Furthermore, the credit and banking systems lack a mechanism for allocating funds among sectors. Instead, investment serves as the primary channel of interaction between the monetary and real parts of the economy. Unlike in Keynesian models, this linkage does not rely on interest rates.

Vernardakis concludes that the primary challenge for the Greek economy is not merely the level of investment but its allocation across various sectors. The domestic economy lacks an inherent mechanism for sectoral shifts toward more productive activities. Addressing this issue would require targeted policies and institutional reforms.

Macroeconometric model KEPE-LINK

This model consists of three agents, households, firms and government. It is a relatively small (100 equations) aggregate, medium-term, model that determines one branch and one product. Its tradition goes back to Tinbergen, whereas the model follows the traditional Keynesian approach that respects Lucas' critique to rational expectations. A Keynesian model focuses on the demand-side, emphasizing the role of government intervention, fiscal policy (e.g., government spending, taxation), and monetary policy in stabilizing economic fluctuations, particularly in the short run. It moreover assumes that markets may not clear quickly, leading to unemployment and underutilized resources. Lucas' critique (1976) on the other hand, argues that traditional macroeconomic models, especially those used in the 1960s and 1970s, failed to account for how rational agents – households and firms – adjust their behavior in response to changes in economic policy. In particular, it was argued that models with fixed behavioral parameters (like consumption and investment functions) are flawed because expectations about policy

changes can alter their decision-making, leading to different outcomes than of those predicted by the model.

In practical terms, this means that economic agents in the model are forward-looking and adjust their behavior based on their expectations of future policies. The model relies on the behavior of individual agents (firms, consumers) rather than aggregate relationships, ensuring that these behaviors are consistent with rational expectations. Unlike traditional Keynesian models, which might predict a straightforward response to fiscal or monetary policy, a model that respects Lucas' critique recognizes that the effectiveness of policy interventions may be limited if agents alter their behavior in anticipation of these policies. Such a model blends Keynesian insights on the importance of demand management with more modern tools that account for how people and businesses adapt to policy shifts. It is a small, demand-oriented model, that considers an exogenous monetary sector where the interest rate is determined by administrative decisions (not by the market).

Capros et al. (1990)

The model developed by Capros, Karadeloglou, and Mentzas (1990) employs a New Keynesian framework, blending macroeconometric (ME) and computable general equilibrium (CGE) approaches to analyze the Greek economy. It features 320 dynamic nonlinear equations designed to simulate the interactions within the fiscal, monetary, and external sectors of the economy. These equations incorporate key macroeconomic variables, ensuring the model's robustness for both policy analysis and forecasting.

The ME model draws on Keynesian principles, prioritizing quantity adjustments over price mechanisms in determining equilibrium. It captures short-term dynamics through equations that model consumption, investment, government spending, and labor market behavior. *Consumption* is a function of disposable income and expectations about future income, expressed as:

$$C_t = a_0 + a_0 Y_t + a_0 E(Y_{t+1}) + \epsilon_t$$

where C_t is current consumption, Y_t is disposable income, $E(Y_{t+1})$ represents expected future income, and ϵ_t is the error term. *Investment* is linked to capital stock and output, reflecting Keynesian accelerator principles:

$$I_t = \beta_0 + \beta_0 K_{t-1} + \beta_2 Q_t + \eta_t$$

where I_t is investment, K_{t-1} is lagged capital stock, Q_t is Tobin's Q (investment profitability indicator), and η_t is the stochastic error. *Government Spending* equations capture fiscal policy effects on aggregate demand:

$$G_t = G_{t-1} + \gamma_0 + \gamma_1 D_t + v_t$$

with G_t as government expenditure, D_t as the fiscal deficit, and v_t as random disturbances. Labor market dynamics are modeled with a focus on employment adjustments to aggregate demand. The quantity of labor is determined by firms' expectations of output rather than real wage flexibility, highlighting the Keynesian emphasis on demand-driven employment.

The CGE model introduces Walrasian equilibrium principles, relying on price adjustments to ensure market balance. It employs a CES (constant elasticity of substitution) production function to capture the supply-side dynamics:

$$Q_t = A_t [\delta K_t^{-\rho} + (1-\delta) L_t^{-\rho}]^{-1/\rho}$$

where Q_t is output, K_t is capital input, L_t is labor input, δ represents the distribution parameter, and ρ controls substitution elasticity between labor and capital. *Trade equations* link imports and exports to relative prices and income:

$$X_t = \phi_0 + \phi_1 R_t + \phi_2 Y_t^* + \zeta_t$$

$$M_t = \psi_0 + \psi_1 P_t^* + \psi_2 Y_t + \xi_t$$

where X_t and M_t represent exports and imports, R_t is the real exchange rate, Y_t^* and P_t^* are foreign income and prices, and ζ_t, ξ_t are errors. *Price determination* integrates inflation and wage dynamics:

$$\pi_t = \lambda_0 + \lambda_1 W_t + \lambda_2 e_t + \varepsilon_t$$

where π_t is inflation, W_t is the wage rate, and e_t is the nominal exchange rate.

The strength of the present model lies in its hybrid design, allowing it to simulate both short-term disequilibrium dynamics (ME) and long-term equilibrium outcomes (CGE). By combining demand-driven and supply-side elements, it accommodates the dual challenges of forecasting and policy evaluation. Its dynamic nature ensures responsiveness to structural shocks, while nonlinear equations capture real-world complexities.

The model demonstrates the centrality of fiscal policy in driving aggregate demand and highlights the limited role of interest rates in Greek financial markets during the analyzed

period. Trade equations underline the sensitivity of the Greek economy to external shocks, such as exchange rate fluctuations and global market trends. The integration of labor market dynamics and price adjustments provides insights into inflationary pressures and employment trends. In conclusion, the model by Capros, Karadeloglou, and Mentzas offers a sophisticated tool for analyzing the Greek economy within a New Keynesian framework. Its methodological rigor and detailed representation of fiscal, monetary, and external sectors make it invaluable for understanding the macroeconomic challenges and for informing policy decisions.

The Bank of Greece econometric model of the Greek economy

The econometric model developed by Nicholas Garganas[25] (Garganas, 1992) as a project of the Bank of Greece, stands out as one of the most significant post-war efforts in Greek economic modeling. Its publication signifies the shift of importance and political power from state agencies towards the central banks, which was in alignment to international developments. This comprehensive model was designed to capture the unique dynamics of the Greek economy during a transformative period, addressing the pressing challenges of persistent fiscal deficits, high public debt, and structural reforms necessary for alignment with the Maastricht criteria for joining the EMU. Its primary objective was to provide robust policy analysis and reliable forecasting tools amidst these macroeconomic pressures.

Built around a traditional Keynesian income-expenditure framework, the model emphasized quantity adjustments driven by expenditures rather than relative prices. Its

[25] Nicholas Garganas is Honorary Governor of the Bank of Greece, a position he has held since June 2008. He served as Governor of the Bank of Greece from 2002 to 2008 and as Deputy Governor from 1996 to 2002. During his tenure as Governor, he was a Member of the Governing Council and General Council of the European Central Bank and served as Greece's Governor at the International Monetary Fund. He joined the Bank of Greece in 1975 as a Senior Economist and later held positions including Director-Adviser in the Economic Research Department and Economic Counsellor (Chief Economist). Before this, he worked as a Research Officer at the National Institute of Economic and Social Research in London and headed the Economic Research Unit of the Agricultural Bank of Greece.

Garganas has held several key roles, including Chairman of the Hellenic Deposit Guarantee Fund, Member of the Economic and Financial Committee of the European Union, and Chief Economic Adviser in Greece's Ministry of National Economy. He was also involved with various European and international economic committees, including the Monetary Committee of the European Communities and the OECD Economic Policy Committee. He holds a degree in Economics from the Athens School of Economics and Business, an MSc from the London School of Economics, and a PhD in Economics from University College London. In recognition of his contributions, he was named an Honorary Fellow of the London School of Economics in 1998.

theoretical foundation drew inspiration from the work of Klein and Goldberger (1955), offering a strong fit for the 1958–1988 period, on which its estimations were based. The model notably eschewed a production function or discussions of technical progress, treating supply as passive and responsive to demand fluctuations. Selling prices were not continuously adjusted, departing from the assumptions of real business cycle theory. Inflation was instead influenced by wages and the exchange rate, which in turn affected consumption patterns.

The structure of the model followed a standard classification. Consumption was broken down into durables, nondurables, and services, while fixed investment was categorized into residential, business, and agricultural activities. Output was only lightly disaggregated between agricultural and nonagricultural production, with manufacturing linked to a composite expenditure determined through weighted input-output tables. Factor payments were separated into wages, dividends, and profits, while the public sector was treated with particular emphasis, featuring multiple categories of taxes and tax rates for estimation. Garganas stressed the importance of enhanced monitoring of the fiscal sector.

A distinctive feature of the model was its treatment of the monetary sector, where credit availability took precedence over interest rate fluctuations. The latter, having remained relatively stable with even negative real levels, played a limited role in affecting expenditure levels. Instead, credit supply was determined by bank credit, considered independent of demand, and tied to investment decisions, which were not always fulfilled. This approach reflected the unique characteristics of Greece's financial system at the time. The model incorporated 507 variables, of which 84 were determined by behavioral equations, 39 by technical equations, and 182 by identities, with the remainder exogenous. Its primary purpose was to support policy responses and provide forecasts. The passive treatment of the supply side, wherein producers were assumed to be capable of meeting expected demand, underscored the centrality of expenditure decisions.

In addition to its technical merits, the model served an educational and institutional role within the Bank of Greece. It fostered a culture of quantitative analysis and evidence-based policymaking, enhancing the institution's capacity to address economic challenges in a rapidly integrating European context. By training staff in econometric techniques and model-building, it contributed to developing expertise that would inform future policy analysis.

Despite its groundbreaking nature, the model faced limitations, particularly in addressing informal economic activities and structural rigidities prevalent in Greece. Its reliance on linear relationships and stable coefficients also constrained its adaptability to rapidly changing conditions. Nonetheless, the model remains a landmark achievement, offering valuable insights into the interplay of fiscal, monetary, and external sectors and underscoring the importance of policy-oriented economic modeling during a critical juncture in Greece's economic history.

A Four-Sector Macroeconometric Model for Greece and the Evaluation of the Community Support Framework 1994–1999

The macroeconometric model of Christodoulakis and Kalyvitis (1998) provides a detailed framework for analyzing the Greek economy in the context of the EU structural funding initiatives. This model was developed with the primary aim of evaluating the economic impact of the Community Support Framework (CSF), a key EU policy instrument designed to promote growth and structural adjustment in member states. The paper focuses on the 1994-1999 programming period, a critical phase for the economic integration of Greece into the EU and its development trajectory.

The model is rooted in Keynesian economic theory, emphasizing demand-driven dynamics in the short run while incorporating structuralist elements to address sectoral interdependencies. Unlike supply-driven models based on neoclassical assumptions, this model focuses on expenditure-side mechanisms, such as investment, consumption, and fiscal policy interventions. It acknowledges the importance of sectoral heterogeneity and structural characteristics, which are crucial for understanding how EU structural funds can drive growth and reduce regional disparities. Moreover, the model is designed to assess the macroeconomic and sectoral effects of large-scale public investment programs financed through the CSF. It evaluates the influence of these investments on economic growth, sectoral output, and employment while simulating alternative policy scenarios to optimize the allocation of resources across different sectors of the economy.

As the title suggests, the model disaggregates the Greek economy into four distinct sectors: agriculture, industry, services, and public administration. This sectoral breakdown enables the analysis of the distinct dynamics and contributions of each sector to the overall economy with an emphasis on expenditure-side determinants of output, including private consumption, investment, public spending, and exports.

Investment, in particular, is a central variable in the model, reflecting the transformative impact of public infrastructure projects funded by the CSF.

On the other hand, public sector dynamics are explicitly modeled, incorporating government consumption, investment, and taxation. This feature allows for a detailed examination of fiscal policy interventions and their implications for economic growth and the allocation of resources. The model also accounts for input-output relationships between sectors, reflecting spillover effects from sector-specific investments. For instance, infrastructure projects in transportation can influence productivity and output in agriculture or industry.

Employment dynamics are modeled within each sector, enabling the analysis of how investments and structural adjustments affect labor demand. By incorporating sector-specific labor market characteristics, the model provides insights into the broader employment effects of structural funds. The robustness of the model lies in its comprehensive coverage of the Greek economy's sectoral structure and its alignment with empirical data. Historical data for Greece is used to estimate the model, with behavioral equations capturing the relationships between key macroeconomic variables and accounting identities ensuring internal consistency. This rigorous econometric foundation allows for the generation of accurate forecasts and the evaluation of various policy scenarios, such as reallocating structural funds or modifying fiscal policies.

The results of the model highlight the significant economic impact of the CFS. The simulations suggest that EU structural funds contributed to increased economic growth, particularly through public investment in infrastructure and productive sectors. However, the model also underscores the importance of the allocation of resources among sectors. It reveals that while the total level of investment is critical, the efficiency of its distribution across sectors significantly influences overall economic performance and structural transformation. For example, investments in high-productivity sectors such as industry and technology yielded more substantial growth effects compared to investments in less productive areas.

One notable feature of the model is its treatment of the monetary sector. It captures the availability of credit rather than relying on fluctuations in interest rates, which remained relatively stable during the period under consideration. This approach reflects the limited role of interest rates in influencing expenditure levels and investment decisions in Greece during this time. Instead, the supply of credit is tied to bank lending, which is often

independent of demand and associated with investment decisions that are not always satisfied.

Despite its robustness, the model is not without limitations. Its reliance on historical data and linear relationships may constrain its adaptability to rapidly changing economic environments or nonlinear dynamics. Moreover, the assumption of passive supply-side dynamics in the short run may overlook the potential for structural changes and long-term productivity improvements driven by policy interventions.

In conclusion, the model represents a significant contribution to the study of the Greek economy and the evaluation of EU structural funding initiatives. By providing a detailed analysis of sectoral interdependencies and public investment dynamics, the model offers valuable insights into the role of structural funds in driving economic growth and structural adjustment. While it highlights the transformative potential of public investment, it also emphasizes the need for strategic resource allocation to maximize growth and ensure sustainable development. This model remains a foundational tool for policymakers and researchers seeking to understand the economic impacts of large-scale public investment programs in small, open economies like Greece.

The Greek country model of the ECB

The GR-MCM model, developed by Sideris and Zonzilos (2005) is a dynamic stochastic general equilibrium (DSGE) framework designed specifically for the Greek economy. It is part of the European System of Central Banks' Multi-Country Model (MCM). Below is a comprehensive description of the model, including its features, school of thought, assumptions, results, and an overview of the key equations that structure its operation.

The GR-MCM integrates short-term Keynesian dynamics with long-run neoclassical equilibrium principles. This dual framework aligns with the New Keynesian school of thought, which blends microeconomic foundations with macroeconomic modeling to account for rigidities and market frictions. Developed during the economic transition of Greece into the EMU, the GR-MCM provides a platform for analyzing fiscal and monetary policies, trade dynamics, and the impact of external shocks. Its primary objective is to generate policy-relevant insights and forecasts for the Greek economy during the critical period following the 1980s.

The GR-MCM operates under the following assumptions: *Short-run Keynesian dynamics* govern output determination, driven by aggregate demand. *Long-run neoclassical*

equilibrium dictates output and factor markets, determined by labor, capital, and technological progress. *Backward-looking expectations* approximate agents' behavior, using lagged variables to simulate expectations. *Exogenous monetary policy* influences key variables, including the nominal exchange rate and interest rate.

As far as the man structure of the model is concerned, the following may offer a general view of its main aspects.

Supply Side: A Cobb-Douglas production function forms the backbone of the supply side:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$$

where Y_t is output, A_t represents technological progress, K_t is capital stock, L_t is labor input, and α is the capital share. The demand for labor (L_t) and capital (K_t) is derived by firms maximizing profits:

$$\text{Wage: } W_t = \frac{\partial Y_t}{\partial L_t}, \quad \text{Rental Rate of Capital: } R_t = \frac{\partial Y_t}{\partial K_t}.$$

Price adjustments follow unit cost structures:

$$P_t = ULC_t + \text{markup}.$$

Demand Side: Private consumption (C_t) is modeled as a function of disposable income (Y_d) and household wealth (W_h):

$$C_t = \beta_1 Y_{d,t} + \beta_2 W_{h,t}.$$

Investment (I_t) depends on output (Y_t) and the real cost of capital (R_t):

$$I_t = \gamma_1 Y_t + \gamma_2 R_t.$$

Exports (X_t) and imports (M_t) respond to relative prices (P_t) and external demand:

$$X_t = \delta_1 P_t^* + \delta_2 Q_t, \quad M_t = \phi_1 P_t + \phi_2 Q_t.$$

Price and Wage Dynamics: Wages (W_t) adjust to productivity in the long run but deviate due to rigidities:

$$W_t = W_{t-1} + \lambda(P_t - P_{t-1}).$$

Domestic prices (P_t) respond to production costs and inflation persistence:

$$P_t = \theta P_{t-1} + (1-\theta) ULC_t.$$

Public Sector: Government spending (G_t) and revenues (T_t) are modeled exogenously, with tax revenues linked to nominal GDP:

$T_t = \tau Y_t,$

where τ is the tax rate.

The GR-MCM delivers plausible short- and long-run responses to various policy shocks, demonstrating its utility in simulation and forecasting. Key findings include:

- Fiscal Policy: Increased government spending raises short-term output and inflation, with potential medium-term trade-offs in competitiveness.
- Monetary Policy: Adjustments in exchange rates and interest rates impact trade balances and inflation, underscoring the importance of credible policy.
- Trade Dynamics: External demand shocks and relative price changes significantly affect output and employment, reflecting Greece's dependence on trade.

The GR-MCM distinguishes itself through its rigorous econometric foundation. By employing cointegration analysis and error correction modeling, it captures both equilibrium relationships and short-term dynamics effectively. Despite certain limitations, such as the absence of forward-looking expectations and limited treatment of the monetary sector, the model excels in its interpretability and practical relevance for Greece's economic policymaking during a transformative period. This dynamic approach and emphasis on structural consistency make the GR-MCM a valuable tool for analyzing Greece's macroeconomic challenges and for providing insights into effective fiscal and monetary policies.

The KEPE model (2011)

The KEPE model has been developed on the basis of two distinct econometric approaches to forecast the short-term trajectory of the macroeconomic variables of Greece: (a) it follows a *structural factor model* for short-term analysis, and (b) a Seemingly Unrelated Regression Equations (SURE) model.

The Structural Factor Model (short-term) leverages key indicators of the Greek economy (KEPE 2011). This method condenses the behavior of these indicators into a limited set of factors capable of explaining and predicting GDP trends. Unlike traditional macroeconomic models, this framework operates independently of specific assumptions about the economy's structure or functioning. While this independence enables a more flexible approach to

forecasting, it also introduces a significant limitation: the model does not account for the influence of economic policies, rendering it as “policy-neutral”.

According to KEPE (2013), the model utilizes seasonally adjusted quarterly data spanning from 2000 to the second quarter of 2013. A total of 144 variables are analyzed, encompassing both real and nominal dimensions of the economy. Real variables include core GDP components (e.g., consumption, investment), industrial production indices, retail activity, travel revenue, labor market metrics, and economic sentiment indicators. On the nominal side, factors such as inflation, monetary aggregates, bond yields, interest rates, exchange rates, and housing price indices are considered. These variables are categorized into two groups: those reflecting the real economy (e.g., trade flows, industrial output, retail activity) and those associated with the financial and monetary sectors (e.g., inflation, foreign exchange rates, and credit spreads).

To evaluate the impact of each sector, the principal components method is applied to extract key factors. Various model configurations are tested to optimize the parameters, with selection guided by information criteria. In its final form, the model incorporates one factor representing the real economy and two factors representing the monetary and financial sectors. Additionally, scenarios are analyzed where only the real economy factor is considered, isolating GDP projections from potential adverse effects in the monetary and financial domains.

The *SURE Model* aims to predict four key macroeconomic indicators i.e., the annual growth rate of real GDP, the unemployment rate, the annual inflation rate as measured by the Harmonized Consumer Price Index (HCPI), and the current account balance expressed as a percentage of GDP.

Forecasts for these variables are constructed based on the following parameters:

Real GDP Growth Rate: Projections are derived from Greece’s and the euro area’s GDP levels from the previous year, alongside the general government deficit as a share of GDP.

Unemployment Rate: Estimates consider prior-year data on unemployment, GDP performance, and competitiveness indicators.

Inflation Rate: Predictions incorporate data from the previous year on changes in oil prices, competitiveness levels, HCPI, GDP, euro area inflation, and the government deficit as a percentage of GDP.

Current Account Balance: Forecasts rely on historical figures for the current account balance, changes in public debt as a share of GDP, Greek and euro area GDP, government deficit as a percentage of GDP, private investment levels, and the annual change in the real effective exchange rate.

The model uses quarterly data. While effective for short-term forecasting, the SURE model is not designed to determine *causal* relationships between variables. Additionally, its predictions come with a high margin of error, warranting cautious interpretation.

A dynamic stochastic general equilibrium model for policy simulations

BoGGEM was developed in 2014 by Dimitris Papageorgiou. It is a sophisticated DSGE model designed to capture the complexities of the Greek economy. It was introduced during a period of significant economic challenges, in the midst of the Greek economic recessionary, providing a framework for analyzing the effects of macroeconomic policies and external shocks in a small open economy. BoGGEM serves as a critical tool for understanding the interplay of fiscal, monetary, and structural reforms, especially in the context of the country's economic struggles during the 2010s.

At its core, BoGGEM integrates the behavior of several economic agents, including households, firms, the government, and the foreign sector. Households maximize their utility over consumption and leisure while navigating budget constraints shaped by wages, taxes, and government transfers. Firms aim to maximize profits by making decisions about production, labor, and investment. The government conducts fiscal policy through taxation, public spending, and debt management, while the foreign sector reflects Greece's interactions with global markets through trade and capital flows.

The model dissects the economy into interconnected sectors. The goods market accounts for the production of tradable and non-tradable goods, while the labor market captures wage-setting dynamics and unemployment trends. The financial market incorporates credit constraints, emphasizing the importance of access to capital given

Greece's financial vulnerabilities. The external sector plays a crucial role, reflecting trade balances, exchange rates, and exposure to external shocks.

BoGGEM is calibrated using historical data, aligning its assumptions with Greece's unique economic realities, particularly the challenges of fiscal imbalances and structural inefficiencies. The model examines dynamic relationships through impulse response functions (IRFs), which track how key economic variables such as output, inflation, and employment respond to different shocks over time. It also uses variance decomposition to identify the proportion of variability in these variables attributed to specific types of shocks, such as productivity changes, demand fluctuations, or fiscal policy adjustments.

A defining feature of BoGGEM is its focus on stochastic elements to account for uncertainties and exogenous shocks. These include productivity disruptions, demand variability, and external factors like exchange rate volatility. The model places particular emphasis on the interplay between fiscal and monetary policies. On the fiscal side, BoGGEM evaluates the effects of government spending, taxation, and debt sustainability, offering insights into the economic consequences of austerity and fiscal consolidation. On the monetary side, it highlights the central bank's role in influencing interest rates, inflation, and liquidity, particularly within the constraints of the Eurozone.

Moreover, the model is a valuable tool for policy evaluation, enabling the analysis of fiscal reforms, labor market adjustments, and structural changes. It also supports the development of counterfactual scenarios, such as assessing the potential impact of alternative fiscal policies or external shocks like global recessions. Furthermore, the model provides a structured approach to crisis analysis, offering pathways for recovery and stabilization.

Despite its robustness, BoGGEM faces certain limitations. Like many DSGE models, it relies on simplified assumptions, such as rational behavior, linear relationships, and perfect foresight, which may not fully capture the complexities of real-world dynamics. Additionally, it does not account for the coutny's significant informal economy or structural rigidities, and its application to monetary policy is constrained by the limited options available to Greece as a member of the Eurozone. In summary, BoGGEM represents a significant advancement in the Bank of Greece's analytical capabilities, providing a detailed and structured framework for understanding the Greek economy's dynamics. Its focus on fiscal, monetary, and external factors offers valuable insights into

navigating economic challenges, making it an essential tool for policymakers and researchers aiming to address the country's macroeconomic vulnerabilities.

Eurobank Real-Time GDP Estimation Model

The econometric model by Eurobank (Monokroussos and Thomakos, 2013; 2014), draws from Evans (2005) and represents a pioneering effort to estimate the country's GDP in real-time fashion. This approach, often referred to as *nowcasting*[26] has gained traction in economics and is widely employed by central banks to evaluate economic conditions contemporaneously (Bandura, Giannone, Reichlin 2010). The model was developed to address the significant delays in GDP updates issued by national statistical authorities, ranging from 2 to 6 months. Moreover, these preliminary figures are frequently subject to multiple revisions. Such delays are not unique to Greece but are a common issue in most European economies, arising from the time-intensive processes involved in data collection, analysis, and dissemination. These lags hinder the timely assessment of economic trends, complicating decision-making for households, businesses, and policymakers alike, particularly in areas of fiscal and monetary policy.

The methodology behind the model can be adapted to provide real-time estimates for not just the GDP but also for other key macroeconomic variables, such as consumer and producer price indices. Its foundation lies in 24 carefully chosen indicators, selected from an initial pool of 60 based on their economic relevance and statistical robustness. While the input data include both monthly and quarterly indicators, the model itself is calibrated using quarterly GDP figures. Unlike the framework outlined by Evans (2005), this model extends beyond traditional macroeconomic variables like retail sales, industrial output, and unemployment. It also incorporates measures of domestic economic activity, such as fluctuations in the Athens Stock Exchange, its volatility, the Euro Overnight Index Average, and the S&P500 implied volatility index. These additions enable the model to account for both domestic and global market dynamics.

[26] According to the IMF: "Nowcasting refers to the practice of using recently published data to update key economic indicators that are published with a significant lag, such as real GDP". See: https://www.imf.org/en/Capacity-Development/Training/ICDTC/Schedule/SA/2023/NWCSA23-32

To ensure precision, each indicator undergoes a transformation to capture its persistence and relative contribution to explaining economic growth. These indicators are then linked to monthly and quarterly GDP data, with all equations treated as stochastic. If interpreted straightforwardly, the model suggests that GDP trends can be projected with a degree of accuracy using GDP itself as a baseline.

The Levy Economics Institute Model

The Levy Institute Model for Greece (LIMG) represents a comprehensive stock-flow consistent (SFC) macroeconomic model designed to determine medium-term policy options for the Greek economy. Developed by Dimitri Papadimitriou, Gennaro Zezza, and Michalis Nikiforos (Papadimitriou et al., 2013a), this model builds on the New Cambridge approach and the SFC methodology pioneered by Godley (2007). It aims to evaluate the implications of various policies implemented on the Greek economy while ensuring consistency between income and expenditure flows and the resulting stock of assets and liabilities across different sectors of the economy.

The LIMG model is built around a demand-driven framework that emphasizes the interconnections between the private sector, government, and the rest of the world. It uses a database of over 150 variables, with quarterly data spanning three decades, derived from reliable sources such as the Hellenic Statistical Authority (ELSTAT) and the Bank of Greece, and complemented by AMECO and IMF datasets. This wealth of data provides a robust foundation of the structure, which consists of 68 equations combining behavioral equations and accounting identities to capture the complexities of the Greek economy.

One of the model's significant strengths is its adherence to SFC principles, ensuring sectoral consistency. Each sector – the private sector, the government, and the rest of the world – is treated as a coherent entity where income and expenditure flows align with the stock of assets and liabilities. This approach allows for a more realistic depiction of economic interactions and provides a strong analytical foundation for evaluating policy impacts. Unlike supply-side models that focus heavily on production functions and market equilibria, the LIMG places demand – both domestic and external – at the core of economic activity. Government expenditures are treated as exogenous inputs, reflecting the influence of fiscal policy decisions, while private expenditures and trade dynamics

are estimated econometrically. This approach allows the model to capture the cyclical nature of economic activity and its responsiveness to fiscal and monetary interventions.

The assumptions provide a structured framework for its analysis. LIMG maintains sectoral consistency by ensuring that all flows of income and expenditure correspond to changes in stock variables, such as assets and liabilities. Price dynamics, while exogenous in the current version, are used to simulate scenarios involving inflation or deflation. Fiscal policy variables, including public investment and transfers, are treated as external inputs to simulate their impact on macroeconomic indicators. Trade determinants are modeled with sensitivity to Greece's external environment, incorporating the GDP of trading partners and competitiveness indices based on price deflators.

The LIMG model has been used to simulate policy scenarios, demonstrating its versatility and practical application. For instance, under a fiscal stimulus scenario involving a 1% increase in public expenditure relative to GDP, the model predicted short-term GDP growth of 1.16% and medium-term growth of 1.4%. The scenario also indicated a gradual improvement in employment, with approximately 39,000 jobs added over two years. However, it highlighted potential challenges such as a widening trade deficit and an increase in public debt-to-GDP ratios in the medium term. Another scenario, focusing on internal devaluation through a 5% reduction in domestic prices relative to trading partners, projected a real GDP increase of 0.8% in the short term and 3% in the medium term. Export growth of 7% was observed after two years, accompanied by a modest decline in imports. While this scenario improved trade balances, it had adverse effects on nominal GDP, leading to higher public and foreign debt-to-GDP ratios due to a lower denominator effect.

The methodological virtues of the LIMG model are particularly evident in its capacity to ensure consistency and coherence in economic analysis. The SFC framework allows for a detailed examination of the interactions between financial balances, stock variables, and real economic activity. By emphasizing the flows and stocks within the economy, the model provides a comprehensive view of how fiscal, monetary, and trade policies interact to shape macroeconomic outcomes. Additionally, its demand-driven nature ensures that policy impacts are assessed in terms of their immediate and medium-term effects on aggregate demand and employment.

Despite its strengths, the LIMG model has certain limitations. The quality and consistency of Greek national and sectoral accounts pose challenges for the model's reliability. Simplistic assumptions regarding price dynamics and fiscal multipliers limit its ability to capture complex real-world phenomena fully. Furthermore, the relatively short time series of available quarterly data restricts the robustness of its econometric estimations. Nevertheless, the LIMG model represents a significant advancement in economic modeling for Greece. It offers policymakers a sophisticated tool for exploring medium-term policy options and assessing their potential outcomes. By focusing on the interconnections between demand, fiscal policy, and trade dynamics, the model provides critical insights into Greece's economic challenges and opportunities. Its adherence to SFC principles ensures a solid foundation for future developments as data quality and availability improve, making it a valuable resource for evidence-based policymaking in Greece.

Concluding Remarks

After the Second World War, the Greek economy was devastated, with immense losses in both human resources and physical infrastructure. This catastrophic state required urgent reconstruction efforts to restore economic functionality and lay the groundwork for future growth. Following the mainstream economic thought of the time, the primary goal of economic planning programs was to industrialize the economy and enhance its productive capacity. Inspired by developmentalist ideas, these programs emphasized state-led initiatives aimed at transforming the largely agrarian economy of Greece into an industrialized one. The emphasis was on building infrastructure, fostering manufacturing, and addressing structural imbalances in the economy to create sustainable pathways for growth.

During the postwar era, developmentalist policies were seen as essential to addressing the challenges of underemployment, income inequality, and trade deficits. Economic reconstruction efforts were driven by the belief that state intervention was crucial for mobilizing resources, guiding investments, and overcoming market failures. This approach aligned with the global consensus of the time, which viewed active State involvement as a necessary precondition for economic modernization, particularly in war-torn and developing economies. However, the mid-1970s marked a significant shift in both the global and domestic economic landscape. The rise of neoliberalism and the

gradual integration of global markets led to a rethinking of traditional state-led development strategies. The Bretton Woods system collapsed, and globalization brought about freer capital flows, reduced trade barriers, and an increased emphasis on market coordination. In Greece, as in many other countries, economic policies began to pivot away from centralized planning and state-led development toward a greater reliance on international markets. The role of the state was redefined, with a focus on liberalizing trade, deregulating industries, and opening up the economy to foreign investment.

This shift fundamentally altered the trajectory of economic development in Greece. While globalization created opportunities for integration into international markets and access to foreign capital, it also exposed the economy to new vulnerabilities, such as trade imbalances, external debt accumulation, and dependence on volatile capital flows. The transition from a state-led developmental model to a market-driven one highlighted the complexities and trade-offs involved in adapting to a globalized economic environment. Ultimately, this period underscores the evolving nature of economic thought and policy, shaped by both domestic needs and global trends.

Within this historical framework, examining some of the most influential economic models developed for the Greek economy since the post-war era, contributes to understanding the evolution of policymaking. Each model encapsulates the unique challenges and opportunities of the specific period in which it was created, providing critical insights into the dynamics of the Greek economy. By merging theoretical constructs with empirical analysis, these models not only deepen our views of the developmental landscape in Greece but also serve as tools for evaluating the criteria used by decision makers and analysts, striving to achieve stability and growth.

The historical evolution of economic ideas and theories since the post-war years has profoundly shaped the trajectory of economic modeling in Greece. In the initial decades, the dominant Keynesian paradigm informed the creation of models designed to facilitate state-led economic planning. These models prioritized growth through industrialization and state-driven investment, emphasizing the structure of production and sources of income generation as central parameters. Early modeling efforts were firmly rooted in effective demand theories, reflecting the broader global consensus on the role of government intervention in steering economies toward growth and modernization.

However, starting in the late 1970s, economic models began to reflect a significant shift in priorities and theoretical foundations. This transformation was driven by Greece's

increasing integration into the EEC and later the EU. The focus of these models shifted from fostering state-led growth to addressing the allocation of resources within the framework of European programs and structural funds. The Keynesian approach gradually gave way to general equilibrium frameworks, which placed greater emphasis on market efficiency, resource allocation, and the constraints and opportunities presented by European integration.

Institutionally, the locus of economic modeling also shifted. While KEPE played a central role in earlier decades, institutions such as the Bank of Greece and other European-aligned entities assumed greater responsibility in later years. This institutional shift marked a significant change in the role of economic sovereignty, as economic policies in Greece were increasingly reflected its obligations and constraints within the EU framework. The purpose of these models evolved alongside their theoretical and institutional transformations. Early models were explicitly aimed at transforming the Greek economy's structure – shifting from low-productivity to high-productivity activities, enhancing labor capabilities, and maximizing capacity utilization. By contrast, later models were more focused on the efficient allocation of European resources, often with an eye toward compliance with EU directives and priorities. This evolution highlights the changing role of economic modeling in shaping Greece's developmental trajectory, from a focus on internal structural transformation to navigating the complexities of economic integration.

In conclusion, the evolution of economic modeling in Greece offers a compelling lens through which to examine the intersection of theory, policy, and historical context. These models, while diverse in their assumptions and purposes, collectively underscore the critical role of economic analysis in navigating the challenges of growth, integration, and modernization. The shift from Keynesian planning to equilibrium-oriented frameworks mirrors broader changes in Greece's economic priorities and institutional affiliations, shedding light on the dynamic interplay between domestic objectives and external constraints. Ultimately, these models not only document the historical development of economic thought in Greece but also provide valuable lessons for future policy design in an increasingly interconnected world.

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