Evolution and Implementation of Macroeconometric Modeling: A Roadmap for INP's Modeling Unit[*]

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Abstract

Macroeconomic modeling is essential for policymaking and economic analysis. This paper examines the role of macroeconomic models in informing policy decisions, with a focus on the Institute of National Planning's (INP) Modeling Unit (MU) in Egypt. Two central questions guide the discussion: which models should the MU prioritize, and what steps are necessary for successful model development? The paper begins by reviewing the evolution of macroeconometric modeling globally, offering insights into the evolution of economic theory, technological advancements, data availability, and methodological approaches that have shaped modeling practices globally. It then delves into Egypt's macroeconomic modeling history, examining past initiatives and drawing lessons for the MU's future endeavors and policy-making efforts. Finally, the paper proposes a roadmap for the MU to develop high-quality models that contribute to Egypt's sustainable economic growth, emphasizing clear objectives, appropriate model selection, long-term strategy, and building trust in research outcome.

Keywords: Macroeconomics, Macroeconometric Models, CGE Model, INP-MU.

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1. Introduction

Over the past eight decades, macroeconomic modeling has evolved significantly, driven by advancements in economic theory, technological progress, and increased data availability (Hendry, 2020). These models play crucial roles in analyzing, forecasting, and managing economic dynamics. They vary in size, structure, and parameter quantification methods (Bårdsen et al., 2005). Macroeconometric models (MEMs) typically estimate parameters using historical data, while computable general equilibrium (CGE) models often employ theoretical design and calibration techniques. Dynamic stochastic general equilibrium (DSGE) models use similar techniques to CGEs, in addition of estimation techniques for parameter determination. Therefore, macroeconomic models are broadly categorized into two types: MEMs and CGEs (Bautista, 1988; Capros et al., 1990; Pollitt et al., 2019).

Recognizing the importance of macroeconomic modeling for policy development, the Institute of National Planning (INP) established the "Modeling Unit" (MU) in 2021 with the specific objective of developing operational macroeconomic models tailored to the Egyptian economy. This paper aims to provide a roadmap for the MU to develop and update MEMs for research and policy studies on the Egyptian economy, addressing two main questions: (i) which MEMs should the MU develop? and (ii) what steps are needed for successful MEMs development?

To achieve this goal, the paper first conducts a brief review of the literature on MEMs building, within the contexts where economic theory and modeling originated, focusing on the key stages in their development. This review highlights the strengths and weaknesses of MEMs, providing insights for the MU to understand the dominant economic theories and methodologies, as well as the associated risks and benefits in macroeconometric modeling. This review focuses on the structural compositions of the models for a single economy and does not address their practical application or delve into estimation considerations. Additionally, the paper reviews Egypt's history of macroeconomic modeling, aiming to inform the selection of appropriate MEM types for the MU to use, considering the specific context and requirements of the Egyptian economy by identifying the gap between Egypt's current modeling practices and the latest advancements in the field.

Accordingly, the paper is organized into four sections, including the introduction. Section 2 reviews the key stages of macroeconometric modeling evolution since the earliest attempts to construct MEMS in the 1930s, offering solutions to core challenges in empirical modeling. Section 3 provides an overview of Egypt's history of macroeconomic modeling, while Section 4 concludes, recommends the types of models MU should construct and outlines a plan to achieve its goals.

2. Evolution of Macroeconometric Models

The foundation of MEMs combines diverse concepts, aiming for a comprehensive approach to empirical system modeling (Hendry, 2020). MEMs trace back to Adam Smith's economic system idea in 1776 which Leon Walras formalized in 1874. Single-variable empirical studies gained popularity in the early 1910s, utilizing Galton's regression analysis, alongside Mitchell's writings on business cycles in the late 1920s. This section offers an over 80 year-long overview of MEMs' evolution, providing insights into their current position. Since the 1936, different generations of empirical system-based MEM have emerged. Fukač and Pagan (2010) and Hall et al. (2013) identified four generations.

2.1. First paradigm shifts in macroeconomics and First Generation (1G) of Keynesian system models (1936- 1960s)

During the 1930s Great Depression and the issue of unemployment, Keynes introduced his influential effective demand theory and challenged classical economics' foundations with governmental policies intervention (Wolf, 2008). Classical economists in the Marshallian tradition believed that unemployment stemmed from wages set above the market clearing level, advocating for wage cuts to restore full employment and minimal government intervention in the economy, a prevailing view among American economists then (Vines and Wills, 2018). However, as the crisis persisted, existing economic analyses failed to explain its severity or propose effective solutions (Stiglitz, 2014).

In contrast, Keynes provided a comprehensive explanation of the Great Depression's causes, with Stiglitz (2014) summarizing the theory into three central ideas: (i) unemployment could persist as markets weren't self-correcting in the relevant time span; (ii) monetary policy was ineffective in deep downturns; and (iii) fiscal policy could stimulate the economy by multiples of government spending increases, swiftly reaching targeted economic activity levels without cyclical overshoot, accounting for private-sector behavioral lags (Phillips, 1954, 1957). Vines and Wills (2018) noted Keynes' additions to the Marshallian model, including nominal rigidities and the introduction of the consumption function, multiplier, and liquidity preference, as "changes in content." This transition was followed by a "change in method" moving to a general-equilibrium analysis (IS-LM system), enabling a deeper understanding of the implications of the "changes in content." This shift, encompassing both content and method, marked a distinct paradigm shift.

This new paradigm guided macroeconomic policymaking for about 25 years, from the end of World War II to early 1970s when the Bretton Woods monetary system collapsed. This period is known as the “Golden Age” because of the economic prosperity it witnessed, marked by high and sustained levels of economic and productivity growth (Vines and Wills, 2018). Thus, Keynes led to three types of revolution as indicated by Veen (2020). The first was the shift in economic thinking, from individual markets to aggregate demand (AD) as the main economic driver. Keynes introduced future uncertainty, normalizing periods of unemployment and idle capacity. The second revolution challenged laissez-faire economics, advocating for a larger government role in stabilizing the economy and achieving full employment and price stability. Keynes proposed counter-cyclical fiscal policies, suggesting deficits during recessions to stimulate spending and surpluses during booms to control inflation. The third revolution occurred in modeling, with economists developing macroeconomic models to test Keynesian theories.

The first-generation model (1G) started with Tinbergen in 1936, evaluating policies addressing the Great Depression in the Netherlands, featuring 24 equations. Despite limitations like a limited number of accounting identities (Dhaene and Barten, 1989), static elements and overlooking the supply side, the model remains a significant contribution to macroeconomic system modeling (Hall et al., 2013). However, it did not receive the same attention as Tinbergen's fully-specified MEM, developed for testing business cycle theories and evaluating policies in the US. This model sparked debates among economists like Frisch (1938) and Keynes (1939), criticized for prioritizing empirical evidence over theory and lacking autonomy in empirical relations. Changes in the economy altered estimated equations, issues still relevant today. Vines and Wills (2018) noted the Phillips-curve equation's introduction into the IS-LM model played a crucial role in shaping macroeconomic models and policy perspectives. Despite Phillips (1954) recognizing the need to reduce AD with positive inflation, Samuelson and Solow (1960) argued for maintaining stable inflation by stabilizing demand, known as the 'natural level of output'.

Three significant developments paved the way for the construction of the first macroeconomic models to encompass the entire economy, supporting Phillips' policy-making process: (i) an increase in the sophistication of measuring National Accounts' variables, making time-series data available; (ii) several crucial breakthroughs in econometric tools developed by the Cowles Commission[1]; and (iii) the development of computer power. Meanwhile, there was a surge of empirical macroeconomics because of the stimulus of Frisch, Klein, and Tinbergen among the influential figures in the field (Vines and Wills, 2018). Following these advancements, the 1G MEMs developed.

In the 1950s and 1960s, macroeconomic models tried to explain and predict many aggregate relationships, resulting in models that were large and practical (Fair, 2015). The 1G models' primary strategy was to lay out the national accounts and subsequently specify the other variables in the model. Klein (1950) was among the first to develop a Keynesian 1G model in US, followed by the Klein-Goldberger model in Goldberger (1959). At that period, Tinbergen (1951), and Klein et al. (1961) developed econometric models for UK.

After the success of Keynesian economics and its ability to predict the effects of the Kennedy stimulus in the early 1960s, Keynesianism gained worldwide acceptance over classical economics (Veen, 2020). This led to the development of large, complex models with an IS-LM orientation, incorporating financial effects through interest rates, largely influenced by Klein's work. Dynamics were mainly handled using a partial adjustment scheme or a finite distributed lag model with few parameters, and inflation was often

[1] The Cowles Commission, established in 1932, aimed to integrate economic theory with mathematics and statistics. It pioneered the estimation of large simultaneous equation models in the US and organized its macroeconomic modeling efforts into three divisions: economic theory, statistical inference, and model construction, emphasizing a team-based approach.

modeled implicitly using a form of the Phillips curve. Macro modeling in the US was further reinforced by models like the large Brookings model incorporating an input-output table (Duesenberry et al., 1965) and widely used US models developed by Data Resources Inc. (Eckstein et al., 1974). These general equilibrium models became increasingly complex, with hundreds of equations, compared to Klein's 12-equation models in the 1940s and early 1950s (Lee, 1978).

In the 1960s, Keynesian economics proposed government-driven demand boosts through wage increases to alleviate unemployment, leading to temporary inflation, following the stable Phillips curve trade-off. This notion supported the potential of full-grown models for economic problem-solving (Sowey & Hargreaves, 1991). Veen (2020) stated that Keynesian ideas were only successful during a period of low inflation variability. However, as inflation increased and became a significant policy concern, Keynesian policies received criticism from classical economists. Economists like Friedman argued that fiscal policy was ineffective and monetary policy should not be used to return the economy to its potential output. Instead, they advocated for a more hands-off approach, emphasizing market reliance over government intervention. This shift in perspective reflects Mankiw's (2006) emphasis on economists adopting an "engineering" perspective, prioritizing practical problem-solving and the implementation of theories in real-world policymaking over merely proposing and testing elegant ideas.

Friedman (1968) and Phelps (1968) proposed persistent increases in AD could trigger a wage-price spiral, gradually raising inflation expectations. This led to the expectations-augmented Phillips curve, becoming vertical in the long run. Adding a new equation to the IS-LM model allowed for adaptive inflation expectations. Friedman and monetarists advocated for economic stability through a money-growth rule controlling the money supply, aiming for long-run equilibrium (Friedman & Schwartz, 1963). They favored market reliance over government intervention (Krugman, 2007). Critics viewed Friedman's rejection of Keynesianism and faith in the free market as misguided (Wolf, 2008).

The 1970s Oil Crises and the Great Inflation prompted demand and inflation-focused policies, raising interest rates, and worsening the supply shock. Friedman's prediction of breaking the inflation-unemployment correlation was confirmed by forecast failures and rising unemployment. Stagflation in the 1970s posed challenges for Keynesian economics (Zinn, 2013). The collapse of the gold standard and US fixed exchange rates further challenged economic models. Many Keynesian economists struggled to provide effective policy advice using existing models such as fixed-price IS-LM models.

Vines and Wills (2018) outlined two responses. The first response was by the 'saltwater economists,' who though remaining interventionist, for example shifted from full-employment Keynesianism to inflation targeting and from active fiscal policy to active monetary policy. These changes directly led to an evolution of existing models and in economic thinking and policies, resulting in the New Keynesian approach. However, they were not a paradigm shift. The second response, by 'Freshwater economists,' involved a revolutionary change in modelling approach and government policies. They entailed models to be microfounded, forward-looking, and optimizing, with future expectations being model-consistent, and assuming the economy at constant equilibrium, and hence no need for policy intervention. The first response was largely accepted, whereas the second was widely declined.

2.2. Second Generation (2G): Big models are evolving with explicit supply-side dynamics

The 2G of MEMs emerged in the early 1970s in US, and later in UK during the 1980s, coinciding with the rise of Monetarism (Fukač & Pagan, 2010). These models were designed to capture different aspects of the economy, such as monetary targeting and flexible exchange rates, in response to evolving events such as inflation and the oil price shocks of the early 1970s. Like the previous generation of models there was considerable diversity within this class, with two key common elements: 2G MEMs grew larger over time, and explicitly incorporated the supply side of the model over longer horizons by including a production function, while maintaining the disaggregated demand equations like 1G models. The 2G models evolved from the 1G models to better handle dynamics and expectations (Fukač & Pagan, 2010). They introduced an inter-temporal dimension for consumption, integrating life-cycle concepts and optimization problems for consumers and producers. Dynamics were incorporated through household wealth and capital stock, accounting for depreciation and savings (Hall et al., 2013).

The U.K.'s LBS and other 2G models innovated by integrating financial system equations to adapt to flexible exchange rates. Initially, a monetary approach determined the exchange rate, leading to the inclusion of a money demand function. Subsequently, 2G models simplified by replacing a full financial sector model with arbitrage restrictions between yields, representing risk or liquidity premiums, as observed in the FRB-US model. In 2G models, the NAIRU (non-accelerating inflation rate of unemployment) was pivotal in assessing inflation acceleration, but doubts emerged regarding their ability to revert to its post-policy changes. (Hall et al., 2013)

Dynamic stability, particularly with rational expectations, necessitates model consistency and convergence to a certain quantity. By the mid-1980s, many U.K.-developed models aimed to exhibit dynamic stability and converge to a steady state or deterministic equilibrium path, though uncertainties persisted regarding the convergence process. Yet, major forecasters criticized econometric models for limited diversity and failures in predicting recessions during 1974-75 and 1981-82. Furthermore, Friedman's money-supply control plan proved ineffective, as inflation was suppressed, and the money-demand relationship was disrupted. Meanwhile, vector autoregressions (VARs), advocated by Sargent and Sims in 1977, offered a theoretical alternative to econometric models. This approach built upon earlier research by Wold (1938, 1949) and Quenouille (1957).

2.3. Third generation (3G): De-Engineering

Unlike the early macroeconomists who had focused on engineering – oriented / practical problem-solving, since the 1990s, there has been a growing tendency to prioritize the development of analytical tools and the establishment of theoretical principles. This shift can be attributed to three waves of new classical economics, each bringing increased rigor and alignment with microeconomic tools, thereby advancing macroeconomics towards a more scientific framework akin to pure sciences. The first wave was marked by monetarism, followed by the rational expectations revolution, and finally, the emergence of real business cycle theories. (Mankiw, 2006)

The 3G models emerged and transformed the traditional model design. They had six central features. First, they were steady-state models based on deterministic growth paths, assuming constancy or deterministic growth in real variables like output and capital, constant rate of labor-augmenting technical change, as per Solow and Swan (Fukac & Pagan, 2010). They also ensured stock-flow consistency by deriving expenditure decisions from households and firms optimized choices. Additionally, they implemented rules such as fixed external debt proportion to GDP and variable fiscal policy. Second, 3G included additional dynamics. Coletti et al. (1996) suggested focusing on fundamental economics and calibrating models based on expert judgments, and not only on econometric techniques.

Third, 3G incorporated an explicit nominal anchor. Taylor (1993) proposed an interest rate rule for stabilizing inflation. *Fourth,* recognizing the importance of the capital equation in the IS-LM model, showing that output does not only depend on labor and cost of raw-material and technology inputs. *Fifth,* emphasizing shocks, 3G models addressed a range of economic disturbances, including technology, monetary policy, etc. *Sixth,* error correction models (ECM) were developed to improve forecasting and policy analysis by accounting for the gap between model variables and their long-run equilibrium values. These changes led to the emergence of New Keynesian models, which served as miniature models for training and thinking about issues, like the role IS-LM played for 1G models and AS-AD for 2G models.

The 3G models took different forms, including an Australian model developed by Murphy (1988), and a multi-country model known as MSG created by McKibbin and Sachs (1989 and 1991). They gained prominence, particularly the Bank of Canada's Quarterly Projection Model (QPM) (Hall et al., 2013). Its modified version was subsequently utilized at the Reserve Bank of New Zealand (FPS). Later adaptations included the Bank of England Quarterly Model (BEQM).

2.4. Fourth Generation (4G): The revolutionary approach—a partial change in paradigm

Due to the inflation problem that occurred during the 1970s and 1980s' oil crises, the 4G models emerged. Advocates of these models argued that during this period the inflation witnessed undermined Keynesian and Friedman economics, and a completely new approach was necessary. Accordingly, DSGE models emerged and gained popularity in

2000s, such as the Global Economic Model of the IMF (Laxton and Pesenti, 2003), ToTEM at Bank of Canada (Murchison and Rennison, 2006), and EDO at the US Federal Reserve (Chung et al., 2010), which differ in scale.

4G models, akin to 3G, utilize a steady-state framework but incorporate microfoundation, rational expectations, and real-business cycle (RBC) ideas, setting them apart. *Firstly,* the microeconomic foundations, rooted in the Lucas critique, reject MEMs for their structural instability (Lucas, 1976). Valadkhani (2004) suggested coefficients of MEMs vary based on agents' responses to implemented and anticipated policy changes, which reduced reliance on older models for policy analysis and prompting research into "deep structural parameters" that led to a shift towards DSGE modeling.

Secondly, according to the Lucas critique, there is a revolutionized advocacy for rational expectations over adaptive mechanisms. Lucas and Sargent (1979) proposed incorporating rational expectations to derive optimization solutions for consumer, firm, and financial behavior, which enhances the depiction of private sector responses to economic policy changes. Thirdly, 4G models implemented the RBC ideas, pioneered by economist Edward C. Prescott (Hall et al., 2013). RBC theory attributes economic fluctuations to changes in productivity driven by technological advances, emphasizing technology shocks over monetary ones (Cooley and Hansen, 1989). This contrasts with the traditional Keynesian view linking fluctuations to AD changes. RBC theory, while departing from Keynesianism, integrates Solow-Swan and Ramsey models to include the supply side. This influenced modern macroeconomics via DSGE models' development, incorporating the supply and demand side of the economy. The New Keynesian Model extends RBC, incorporating a wider range of shocks for a more comprehensive view of macroeconomic dynamics beyond technology (Christiano, et al. 2018). These models are now standard for policy analysis and economic forecasting, with later versions incorporating distortions, such as nominal rigidities, and information problems, for a more realistic portrayal of a competitive economy.

DSGE models, grounded in New Keynesian principles, examine how structural shocks impact the economy over time (Smets and Wouters, 2003). They emphasize the sluggish adjustment of sticky prices and wages, amplifying the significance of monetary policy in shaping macroeconomic indicators such as output, inflation, and interest rates. These models integrate three fundamental equations that define the dynamic behavior of macroeconomic variables. The IS curve delineates the relationship between consumption, investment, and output (King and Kerr, 1996); the Phillips curve, elucidating firms' pricing behavior in a competitive market (Rotemberg, 1982); and the monetary policy rule, dictating central bank actions to stabilize prices and output amidst economic fluctuations by determining the level of the short-term nominal interest rate (Taylor, 1993).

DSGEs, distinct from earlier MEMs (Hall et al., 2013), exhibit several key design features: household intertemporal optimization; stochastic and deterministic technology leading to evolving "steady-state" solutions; explicit modeling of shocks considering their persistence for comprehensive dynamics; microeconomic foundations demanding system estimation tools; incorporation of heterogeneous factors impacting investment decisions; and utilization of the Calvo pricing scheme, with a firm that can optimally reset prices and others must follow.

Despite their advantages, DSGEs failed to predict the 2008 Global Financial Crisis (GFC), which represented a systemic failure of the economics profession. This raises debates on the effectiveness of DSGEs in predicting and responding to economic crises. Opinions have diverged, some see them as a sign of macroeconomics maturing, others see them as problematic leading to a dead end. Acharya (2009) criticized the lack of the financial sector, systemic risk, market imperfections, and irrational behavior in the models, which led to inaccurate predictions of economic outcomes and the GFC. Also, economists overlooked key factors like decision rule heterogeneity and social shifts before GFC, resulting in models that inadequately capture real economic dynamics (Colander et al., 2009). Recently, Blanchard (2018) advocates that DSGEs are based on unappealing assumptions that are at odds with what is known about consumers and firms; have methodological issues in their estimation due to the large number of parameters, making it unfeasible to estimate them all; and their normative use can be misleading, as they disregard important issues for welfare like distribution effects and the effects of current policies on future GDP.

On the other hand, DSGE’s defenders argued that these models were not designed to study or predict large crises, but to use during non-crisis periods (Del Negro and Giannoni, 2017). DSGEs can also estimate important unobservable variables, such as the natural rate of interest. They have been useful in informing researchers on the sources of business cycles (Justiniano et al., 2017). They have been refined overtime using Bayesian procedures and multi-indicators approaches, better capture of financial frictions and credit constraints to account for the financial sector's role in the economy, enriched tools for policymakers, and the development of settings with heterogeneous agents (Smets & Wouters, 2007). Also, Coenen et al. (2012) advocated DSGE’s explicit modeling of expectations reduces their vulnerability to the Lucas critique. Finally, Christiano et al. (2018) cited DSGE’s microeconomic foundations and theoretical soundness.

After this debate, most economists suggested rebuilding the DSGEs with varying degrees of modifications (Stiglitz, 2014; Fair, 2015; Vines & Wills, 2018, 2020). It's important to note that no single model represents absolute truth, so comparing results from multiple models is crucial.

2.5. New core model as a benchmark

Several macroeconomists raise concerns about liquidity constraints and leverage's impact on borrowing capacity. Blanchard (2017) emphasized the influence of "own funds" on spending decisions. Stiglitz (2018) highlighted risk's significant effects, while Vines and Wills proposed an endogenous yield curve. Carlin and Soskice (2018) advocated for a financial accelerator and a leveraged banking system. Ghironi (2018) suggested incorporating a financial sector and modeling financial frictions.

Moreover, Lindé (2018) stressed the importance of forward-looking behavior instead of rational expectations that lead to flawed policy estimations, such as low estimates of fiscal multipliers (Stiglitz, 2018). Suggestions include incorporating finite horizons, less rigid frameworks like agent-based models, and accounting for heterogeneous agents and income distribution. Ghironi (2018) stressed firm heterogeneity and strategic interactions within networks. Vines and Wills (2018) warned against using a representative agent approach, arguing that categorizing consumers doesn't address underlying heterogeneity.

In recent times, there has been a reevaluation of macroeconomic modeling foundations, particularly within the DSGE framework, traditionally a key benchmark. The goal is to refine the existing framework by incorporating new concepts and discarding outdated elements, aiming to create a more accurate model reflecting economic dynamics and compatible with evidence-based policymaking.

The Oxford Review of Economic Policy (OxREP) 2018 special issue addressed the flaws of the New Keynesian DSGE (NK-DSGE) model, advocating for a "new core model". Blanchard (2018) and Krugman (2018) emphasized DSGE's modularity and adaptability, allowing for extensions, with Krugman calling for a reassessment of the natural rate of unemployment and Blanchard focusing on deeper analysis of price stickiness (Blanchard, 2018). Additionally, Wright (2018) suggested a theory of individual trade with explicit frictions mirroring real-world complexities. Institutions should evolve endogenously, replacing those not properly microfounded with ones arising from structural frictions (Haldane and Turrell, 2018).

Stiglitz (2018) advocated for aligning data with core/policy models by discarding the Hodrick – Prescott (HP) filter and establishing standards for assessing goodness of fit. Henry and Muellbauer (2018) emphasized incorporating significant variables and structural shifts, at least through intercept adjustments and time-varying parameters, for reliable individual equation estimation. Lindé (2018) and Stiglitz (2018) emphasized synergy between big and small models to account for the theoretical framework and practical insights.

Vines and Wills (2018b) proposed four adjustments to the current economic model: revising or substituting behavioral equations for consumption, investment, and price-setting, and creating a gap between the policy rate and the rate influencing consumption and investment decisions. They also proposed policy models addressing common issues, complemented by satellite models tackling less central or general-equilibrium matters. Reis (2018) and Stiglitz (2018) proposed short-term Keynesian-style outcomes and longer-term equilibria growth, recommending gradual implementation due to complexity. These changes signal a departure from the pre-GFC benchmark model, but the methodological change is insufficient for a true paradigm shift.

In 2020, OxREP in collaboration with Vines and Wills aimed to expedite the advancement of a Multiple Equilibrium And DiversE (MEADE) paradigm, expecting to soon replace the current NK-DSGE that is becoming obsolete. Guzman and Stiglitz (2020) argued that the NK-DSGE model, designed for fluctuations, is inadequate for analyzing severe downturns, first, due to its linear nature and inability to simulate good and bad outcomes. Also, detailed empirical analysis was needed, which NK-DSGE models do not consider. Instead, Fair (2020) suggested complementing NK-DSGEs with structural economic models (SEMs), accounting for behavior leading to adverse outcomes.

3. Evolution of Macroeconomic Modeling in Egypt

This section aims to review the evolution of macroeconomic models in Egypt since the late 1950s and the motivations and objectives that drove their developments. It aims to identify lessons that would inform the future path of INP's MU in building models that improve understanding of the Egyptian economy and the effectiveness of policy responses.

To our knowledge, only Lofgren (1994) and Thissen (1998) have reviewed the use of CGE model in Egypt. To fill this gap, thorough investigations, meeting with leading economists and experts in Egypt were conducted. Their insights, along with literature review, formed the basis for constructing a historical account of MEMs in Egypt. Acknowledging the absence of documentation for the studied period, the research recognizes potential biases from relying on expert testimony. Nevertheless, the findings offer valuable insights into Egypt's macroeconomic policy evolution, encouraging further research in the field

3.1. Egypt's first attempts to modeling

Egypt's initial foray into modeling began with the revolution of July 1952, which ushered in a new regime that focused on social justice and rapid development. Thus, the National Planning Committee (NPC) was established in 1955 under Law No. 141 of 1955 to develop Egypt's comprehensive national plan for economic and social advancement. The first five-year national plan (1960-1965) was formulated to align with this vision, outlining forecasts and targets for national production, income, consumption, saving, investment, and employment, with only the investment program having detailed policies.

During this period, Egypt sought to stimulate economic growth and employment through strategically chosen investment projects aligned with the plan's objectives, while also avoiding unforeseen financial deficits that could destabilize the economy (Frisch, 1965). However, challenges, such as data limited availability and inconsistency, constraints in computing resources, and a shortage of experienced researchers hindered the development of a MEM.

The NPC and INP sought to adopt investment planning models from European nations like France, and Denmark, with assistance from leading planning experts. To accomplish this, they enlisted renowned economists like Tinbergen, Zimmerman, and Frisch to contribute to Egypt's investment planning project. These experts developed the Cairo-

Oslo Model, the first-ever model customized for the Egyptian economy. Frisch tailored the Norwegian model for Egypt's economy. Using various programming techniques, he enhanced accuracy for efficient national planning and resource allocation in Egypt. Meanwhile, the NPC began working on building a macroeconomic database, while the Scientific Computation Center started reviewing literature on models, focusing on the 2-gap model.

However, planning and modeling initiatives were disrupted by June 1967 war and subsequent fiscal austerity measures, halting educational scholarships until late 1980s and diminishing modeling endeavors. Consequently, from the late 1960s to the mid-1970s, no governmental or academic initiatives arose to nurture Egyptian expertise in designing models depicting the complex economic dynamics and offering insights for policymaking.

3.2. Egypt's CGE models

Since 1970s, CGEs have become standard tools for policy analysis in Egypt, probably because they do not require as much detailed data as MEMs. The first CGE for Egypt was developed by Taylor in 1976 as part of a World Bank project, with a focus on food subsidies (Lofgren, 1994). In 1977, Cairo University and M.I.T. initiated a research project to develop Egypt's first disaggregated Social Accounting Matrix (SAM) for 1976, laying the groundwork for the country's CGE model crafted by Eckaus et al. (1979). This led to various studies utilizing the model or/and the 1976 SAM, including works by Boutrus-Ghali and Taylor (1980), Eckaus et al. (1980, 1981), and Eckaus and Mohie-Eldin (1980) inspired by Taylor's models developed for Pakistan and India (Lofgren, 1994).

Between 1981 and 1983, efforts were made to enhance Egypt's databases. The "Economy-wide Modeling and SAM Updating" project, involving Cairo University, Egyptian ministries, and WB, resulted in a disaggregated SAM for 1979. Subsequently, Egypt's Central Agency for Public Mobilization and Statistics (CAPMAS) launched a project for producing SAM 1980/81. This initiative led to the development of the first Egypt's CGE model primarily designed by Egyptians (Khorshid, 1984; Kheir-El-Din et al., 1984; and Khorshid and Kheir-El-Din, 1984).

MISR2, crafted by Ahmed et al. (1985) using the 1979 SAM for WB, was considered cutting-edge for its high level of disaggregation in foreign exchange and production. Meanwhile, MISR3, developed by Kheir-el-Din and El-Laithy (1990), using 1983/84 SAM from a joint Cairo University and CAPMAS team. All mentioned models were static except for Ahmed et al. (1985) and Dethier's (1985) dynamic CGEs in Egypt.

Subsequently, CAPMAS (1991; 1995) institutionalized SAM development, providing a consistent database for CGE modeling. This led to the creation of several models, influenced by the structural approach pioneered by Dervis et al. (1982) and Taylor (1983). While newer models built on earlier ones, they vary in focus, resulting in sophisticated sections alongside stylized ones. Earlier CGEs for Egypt were predominantly macro (Thissen, 1998), with Walrasian models published in the mid-1990s.

CGEs have become vital tools in Egypt's economic research, facilitating the simulation of distributional effects of various policy options and enlightening decision-making. Egypt's CGE research spans diverse topics using different models, ranging from highly stylized ones like Pleskovic (1982) and Umari (1990) to more sophisticated ones like Khorshid and Osman (1986), Lofgren (1995), and Eldeep and Zaki (2023).

3.3 Egypt's Structural, Time Series Analysis, or DSGE Modeling

Also, some researchers have employed simultaneous equations methods to estimate macroeconomic models for Egypt. For instance, Thabet (1992) studied policy impacts on Egyptian growth from 1960-1991. Following Fair (1984), Al-Shawarby (1997) developed a large MEM comprising 19 behavioral equations and 85 identities, utilizing 173 variables, to assess the impact of the Economic Reform and Structural Adjustment Program on the Egyptian economy spanning 1967-1993. However, large-scale models, requiring extensive data, may be less favored for academic use, lead to a focus on time series analysis.

Since early 2000s, research on Egypt have increasingly utilized time series analysis to address macroeconomic issues. For example, using Structural VAR (SVAR) model, Hassan (2003) assessed the monetary policy transmission mechanisms. Torayeh (2011), using cointegration analysis and Error Correction Model (ECM), determined the causality between exports and economic growth. Elsherif (2015) employed Autoregressive Distributed Lag (ARDL) to investigate the determinants of financial market development. Rofael and Hosni (2015) estimated and forecasted the volatility of exchange rates in Egypt, using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model. Also, Hosni (2020) measured the dynamic effects of public debt on economic growth using SVAR and ARDL models.

DSGEs gained popularity in Egypt, particularly for analyzing monetary policy. Moursi and El Mossallamy (2009) utilized small, open economy DSGE model to study various shocks' impact on output. Al-Shawarby and El-Mossallamy (2018) employed NK-DSGE model to assess policy interactions' effects on economic stabilization. Elgebaly (2020) estimated a sticky price DSGE model to explain economic dynamics.

Overall, Egyptian economists have adapted international models independently since the 1990s. However, Egypt's individualistic modeling approach limits expertise accumulation and hinders model refinement. Unlike in US and UK, there is insufficient institutional support for collaborative model building in Egypt, which is crucial for addressing evolving economic challenges.

4. Conclusion and recommendations

The development and utilization of macroeconomic models in Egypt are crucial in navigating the country's current challenges, including uncertainties, policy reforms, and climate-related issues. The establishment of the (MU at the INP signals a commitment to providing policymakers with insightful analyses for informed decision-making. This development raises has two central questions: which models should the MU prioritize, and what steps are necessary for successful model development by the MU?

To answer these questions, the paper starts with delving into the history of MEMs and concluded that they evolved across multiple generations, reflecting advancements in economic theories and empirical insights. From the Keynesian era to the emergence of RBC and DSGEs, the quest for more rigorous frameworks has been evident. Each generation incorporates features from its predecessors while introducing novel elements. Only the Keynesian system models of the first generation were revolutionary, implying a shift in both content and method. The transition from one generation to the next is characterized more by evolution than revolution, signifying a gradual progression and refinement of modeling techniques and methodologies.

The recent discourse on refining macroeconomic modeling, particularly within the DSGE framework, highlights the need for models that better capture real-world complexities and dynamics. Suggestions for a "new core model" emphasize the incorporation of updated concepts, such as individual trade theory and endogenous institutional evolution, to enhance the accuracy and relevance of economic models. This signifies a paradigmatic shift towards a Multiple Equilibrium and DiversE (MEADE) paradigm, aiming to address the limitations of existing models in analyzing severe downturns and complex economic dynamics. As economists continue to refine and innovate macroeconomic models, the pursuit of more robust and adaptable frameworks remains paramount for informing evidence-based policymaking and understanding the intricacies of modern economies.

In Egypt, macroeconomic modeling has been predominantly driven by individual researchers, and relied on data availability and intended use. This resulted in a limited accumulation of expertise, fragmentation rather than a unified approach, hampering the development and maintenance of a comprehensive, centralized model capable of addressing multifaceted economic issues efficiently. Recognizing this challenge, the paper emphasizes the importance of institutional support for team-based model building within the newly created INP Modeling Unit (MU) to foster expertise accumulation and continuous model improvement.

Building upon this recognition, the paper suggests a multi-faceted approach to model development and utilization, and proposes a roadmap for the MU to navigate these complexities effectively, with the following pillars:

Firstly, the MU should clearly define the objectives of the models, aligning them with Egypt's economic goals, and addressing specific challenges faced by the economy. The choice of model type and size depends on research priorities. For instance, assessing exchange rate devaluation's impact on exports may require VAR, VEC, or SVAR models. To analyze broader implications of exchange rate fluctuations, CGE or structural MEMs are suitable. DSGEs aid in understanding economic variable interrelationships, while structural MEMs forecast policy effects over time.

Secondly, the MU should adopt diverse model types, such as DSGE, CGE, and SEM, to effectively address various research questions. These models need to continuously get updated and refined with new data to generate valuable insights and inform policy decisions. The MU team should also consider the potential need for MEADE type of model in the future and be prepared for the transition when the time comes. This effort requires effective coordination among different teams within the unit and encourages interaction between different models to leverage their respective strengths.

Thirdly, The MU is recommended to establish a skilled team for model development and maintenance, involving hiring and training experts in empirical modeling, forecasting, and policy analysis, as well as fostering effective communication and networking strategies to engage policymakers and stakeholders, ensuring model responsiveness. Additionally, partnering with other modeling units, universities, and institutions inside and outside Egypt optimizes resources and results in benefits from shared knowledge and expertise while exploring new research areas.

Finally, the MU should establish trust in model-based research and recommendations by transparently communicating model limitations to policymakers and the public. It should clearly convey model weaknesses to encourage critical evaluation and continuously assess and refine models for improved accuracy and relevance.

Conclusively, by following the proposed roadmap, the MU can develop high-quality models tailored to Egypt's economic landscape, informing decision-making processes, contributing to sustainable economic growth and development, and ultimately addressing the challenges faced by the country effectively.

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