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Abstract

This paper examines the effect of the COVID-19 shock on the Egyptian economy using a computable general equilibrium (CGE) model. We contribute to the literature in several ways. First, using a CGE model, we try to distinguish between supply and demand effects of COVID19 on the Egyptian economy. Second, using a dynamic model, we examine the key differences between the effects of the pandemic on the economy in both the short and long terms. Third, we identify how the pandemic and the policy responses of the government had a heterogeneous impact on different economic agents and sectors. Fourth, we modify the model to include the informal labor that was highly affected by the pandemic. We calibrate the mode using the social accounting matrix of Egypt of 2014/2015. Our main findings show to what extent the Egyptian economy has been relatively vulnerable to the world economy with the decline in most of its foreign currency sources. Yet, while the economy is negatively affected in the short term by the pandemic, most of the effects are temporary and vanish in the long run. In terms of the policy response, increasing public current consumption without sectoral targeting has positive welfare effects but hurts economic growth and employment. In contrast, increasing public investment increases growth, welfare, and employment in the short run thanks to more externalities. In terms of social policies, financial transfers to households/domestic business agents and irregular workers increase private consumption but negatively affects economic growth and employment with a deteriorated fiscal stance of the government. Finally, the monetary stimulus package has significant growth, employment, and well-being effects compared to fiscal one since the latter raises the cost of production because of the crowding-out effect, while the former reduces it.

Keywords: CGE, Stabilization policies, Informal workers, Egypt.
JEL Classifications: D58, E63, P41.

ملخص

تبحث هذه الورقة في تأثير صدمة جائحة كوفيد 19 على الاقتصاد المصري باستخدام نموذج التوازن العام المحوسب. نساهم في الأدب بعدة طرق. أولاً، باستخدام نموذج التوازن العام المحوسب، نحاول التمييز بين تأثيرات العرض والطلب لجائحة كوفيد 19 على الاقتصاد المصري. ثانيًا، باستخدام نموذج ديناميكي، نقوم بفحص الاختلافات الرئيسية بين تأثيرات الوباء على الاقتصاد على المدى القصير والطويل. ثالثًا، نحدد كيف كان للوباء واستجابات السياسة الحكومية تأثير غير متجانس على الوكلاء الاقتصاديين والقطاعات المختلفة. رابعًا، نقوم بتعديل النموذج ليشمل العمل غير المهيكل الذي تأثر بشدة بالوباء. نقوم بمعايرة الوضع باستخدام مصفوفة المحاسبة الاجتماعية لمصر لعام 2015/2014. تظهر النتائج الرئيسية التي توصلنا إليها إلى أي مدى كان الاقتصاد المصري ضعيفًا نسبيًا أمام الاقتصاد العالمي مع تراجع معظم مصادر العملات الأجنبية. ومع ذلك، في حين أن الاقتصاد يتأثر سلبًا على المدى القصير بالوباء، فإن معظم الآثار مؤقتة وتتلاشى على المدى الطويل. فيما يتعلق باستجابة السياسات، فإن زيادة الاستهلاك العام الحالي دون استهداف قطاعي له آثار إيجابية على الرفاهية ولكنه يضر بالنمو الاقتصادي والتوظيف. في المقابل، تؤدي زيادة الاستثمار العام إلى زيادة النمو والرفاهية والتوظيف على المدى القصير بفضل المزيد من العوامل الخارجية. فيما يتعلق بالسياسات الاجتماعية، تزيد التحويلات المالية إلى الأسر / وكلاء الأعمال التجارية المحلية والعاملين غير المنتظمين من الاستهلاك الخاص ولكنها تؤثر سلبًا على النمو الاقتصادي والتوظيف مع تدهور الموقف المالي للحكومة. أخيرًا، تتمتع حزمة التحفيز النقدي بآثار نمو وتوظيف ورفاهية كبيرة مقارنة بالميزانية المالية حيث أن الأخيرة ترفع تكلفة الإنتاج بسبب تأثير المزاحمة، في حين أن الأولى تقللها.

1. Introduction

The economic impacts of COVID-19 vary across nations based on the timing, degree of containment measures and the extent of their dependency on the world economy. Moreover, lockdown measures led to a severe contraction of the global economic activity and to a significant reduction of labor and capital mobility. This is why the global growth contraction for 2020 is estimated at -3.5 % (IMF, 2021). Simultaneously the pandemic has led to a demand shock or reduction in private consumption (OECD, 2020). It further led to a sharp fall in world fuel prices since the spot price of Brent oil went from over $66 per barrel in December 2019 to $23 in April and is floating around $55 in January 2021 (World Bank, 2021). Emerging economies, including Egypt, were not spared of this unprecedented shock.

At the national level, the Egyptian government has imposed partial containment measures for a period of 90 days (partial closure of commercial activities and limitation of air and ground transportation), which represented demand and supply shocks to Egypt's economy. On the supply side, social distancing has affected the process of producing goods and services, disrupted global value chains, and reduced the availability of imported intermediate inputs. Consequently, the overall output growth was hurt, leading to employment losses and an increase in informality. On the demand side, reduced household income and uncertainty about the future are expected to drive down private consumption and investment. Indeed, Egyptian GDP fell by 3.1% in the fourth quarter of fiscal 2019/20 from a positive GDP growth of 5.2% in the same quarter of 2018/19. Externally, Egypt's major currency sources experienced a sharp decline as a direct result of COVID-19. Oil exports decreased by 34%, from $2.4 billion in the first quarter of 2019/20 to $1.6 billion in the same period in 2020/21. With the interruption of international flights, tourism revenues in Egypt have declined drastically over this period by more than 80% to less than $1 billion down from $4 billion. Furthermore, net direct investment inflows decreased by 32% in the first quarter of fiscal year 2020/2021 to $1.6 billion compared to $2.4 billion, during the similar period a year before. In addition, payments received from the Suez Canal fell by 8% in the first quarter of F2020/21 compared to the same period in 2019/20. However, remittances inflows to Egypt, the region’s largest recipient in MENA, have so far been countercyclical to the pandemic. They increased by 20% to reach $8 billion up from $6.7 billion (World Bank, 2020). These remittances were one factor that prevented private consumption in Egypt from falling.

Against this background, this paper contributes to the literature in several ways. First, using a CGE model, we try to distinguish between supply and demand effects of the pandemic on the Egyptian economy. Second, since our model is dynamic, we examine the key differences between the effects of COVID-19 on the economy in the short and long term. Third, we identify how the pandemic and the policy responses of the government had a heterogeneous impact on different economic agents and sectors. Fourth, we modify the model to include informal labor in order to simulate the impact of the pandemic on informality in Egypt. In addition, we simulate the effect of providing EGP 500 cash transfers to irregular employees. Finally, we apply this on an emerging country,

namely Egypt that is under-researched in this recent literature. Our main findings show to what extent the Egyptian economy has been relatively vulnerable to the world economy with the decline in most of its foreign currency sources. Yet, while the economy is negatively affected in the short term by the pandemic, most of the effects are temporary and vanish in the long run. In terms of the policy response, increasing public current consumption without sectoral targeting has positive welfare effects but hurts economic growth and employment. In contrast, increasing public investment increases growth, welfare, and employment in the short run thanks to more externalities. In terms of social policies, financial transfers to households/domestic business agents and irregular workers increase private consumption but negatively affects economic growth and employment with a deteriorated fiscal stance of the government. Finally, the monetary stimulus package has significant growth, employment, and well-being effects compared to fiscal one since the latter raises the cost of production because of the crowding-out effect, while the former reduces it.

The paper is organized as follows. Section 2 reviews the literature. Section 3 presents an overview of the main economic developments that took place in Egypt in the wake of the COVID-19 shock and the main channels through which the pandemic affected the Egyptian economy. Section 4 presents the methodology. Section 5 analyzes the results of different simulations and section 6 concludes.

2. Literature Review

The literature on the macroeconomic effects of COVID-19 relies more on multinational models rather than single country ones. While the former help determine the global effects of the pandemic, the latter allows a deeper and a more thorough analysis of individual countries. Moreover, while the literature was chiefly covering Asia and Latin America, the Middle East and North Africa is under-researched.

Regarding multinational models, Djiofack et al. (2020) construct a CGE model to examine the impacts of COVID-19 in sub-Saharan Africa. They introduce different scenarios based on the severity and length of the pandemic and examine the effects of the potential cooperation between countries. They find that this pandemic is likely to cause a long-term impact on labor productivity and GDP. Their simulation results suggest that the African GDP would decline by 4% lower than the growth projected without the COVID-19 shock. In the same vein, Maliszewska et al. (2020), using a global standard CGE model, find that the decline in labor supply and the increase in trade cost will lead to a global GDP slowdown by 2% and 4% for the short and long lockdown scenarios, respectively. They further find that developing countries suffer more than developed ones because service sectors are more important in the former countries than the latter. In addition, McKibbin and Fernando (2020), using a dynamic global hybrid DSGE/CGE mode, show that even a contained spread scenario could significantly affect the global economy in the short-run. Therefore, they recommend increasing public heath investment. Walmsley et al. (2020) develop a

modified version of GTAP to assess the impacts of lock down policies in the U.S.A and other countries. They find that GDP and employment of U.S. would drop by 20% and 22%, respectively due to the three-month lockdown policies. These negative impacts would more than double if the closures policies are extended to six months.

As per single country models, Porsse et al. (2020) use a dynamic interregional computable general equilibrium model to assess the economic effects of COVID-19 on the Brazilian economy. They simulate the impact of a negative labor supply shock and the government's fiscal measures to curb the impact of COVID-19 on the economy. They carry out their analysis on the assumption of 3 and 6 months of closure. They note that the national GDP decreases by 3.78% with a negative labor supply and 0.48% with the fiscal response. They also conclude that the longer the shutdown period, the more severe the effects on economic growth. Moreover, they find that GDP falls by 10.90% and 7.64% with the closure of six months. As such, they stress that the government's fiscal stimulus could partially mitigate the reduction in GDP due to the COVID-19 outbreak.

Several studies employ a CGE model to assess the impact of the COVID-19 pandemic in Asia. For instance, Cui et al. (2020), using a CGE model to analyze the transport sectors, show that the passenger transportation sectors are experiencing larger production declines than the freight ones. Another study by Guo and Shi (2021) uses a CGE model to investigate the effects of fiscal stimulus packages during COVID-19 pandemic by simulating the impact of the value-added tax (VAT) reduction policy. They point out that the local budgetary pressure has increased from 0.342 to 0.435. In another study for India, Malik (2021) uses the global hybrid DSGE/CGE to analyze the adverse impacts COVID-19. He notes that shut down measures could reduce economic output in advanced and major emerging economies by 15% or more. In certain emerging economies, output could fall by 25%, especially for countries that rely heavily on tourism. In contrast, other countries with large agricultural sectors could suffer less.

Malliet et al. (2020) use a neo-Keynesian CGE model to examine the short and long term economic and environmental impacts of lock down measures taken in France. They argue that containment has a negative impact on economic output of 5% of GDP, but a positive, though temporary, environmental impact with a 6.6% reduction in CO2 emissions in 2020. A similar model has been applied on South Africa by Erero and Makananisa (2021) who find that the COVID-19 pandemic could lead to a significant drop in GDP, exports and private consumption of 7.10%, 13.19%, and 7.10%, respectively. In addition, it drives up the unemployment rate due to the sharp drop in sectoral production. They also show that the pandemic is deteriorating the well-being of households due to rising consumer prices and unemployment.

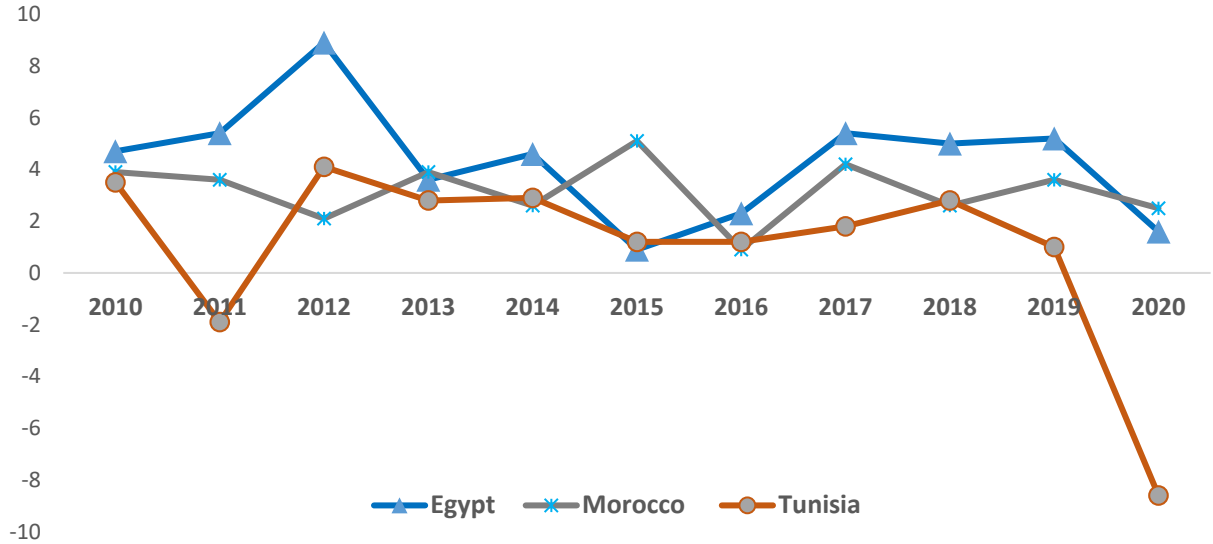
For Egypt, Breisinger et al. (2020) use a multiplier model to examine the short term effects of COVID-19 due to the drop in revenue from tourism and payments received from the Suez Canal. They note that the pandemic reduces GDP by 0.7% and 0.8% for each month of closure. Moreover,

it reduces household spending between 9% and 10.6% of the average household income. Thus, the cumulative GDP loss would be between 2.1% and 4.8% of annual GDP in 2020. To our knowledge, no dynamic CGE model has been developed for Egypt to address the macroeconomic and sectoral impacts of the COVID-19 pandemic and the stimulus measures that were provided by the government. This article aims to fill this research gap by highlighting the heterogeneous impact of the policy response and distinguishing between the short and long term effects. Moreover, we take into account the informal sector that has been severely affected by the pandemic.

3. Recent Developments

Similar to most of the emerging economies, Egypt was negatively affected by the pandemic at both the supply and demand levels. At the supply level, with confinement and social distancing, several plants had to reduce their production, leading to a lower supply of goods, which, in turn, would reduce the demand for labor, whether formal or informal. Yet, informal labor would suffer more given that informal employment accounted for more than half of total employment in Egypt. At the demand level, with the decline in labor demand, wages dropped. Moreover, being highly dependent on tourism, Egypt has suffered from the restrictions measures imposed domestically and internationally. Yet, compared to other countries, Figure 1 shows that Egypt was the least affected by the shock as it was the only country having positive growth rates that reached 1.6% in 2020 down from 5.2% in 2019. The decrease was more pronounced for Tunisia and Morocco whose GDP growth rate was -8.6% and -7.5% down from 1% and 3.6% respectively in 2019. In light of the decline in production, demand for labor and wages, a negative consumption shock is expected, but this did not happen since official data reported an increase in domestic consumption as it will be shown later.

Figure 1. Real GDP growth rates

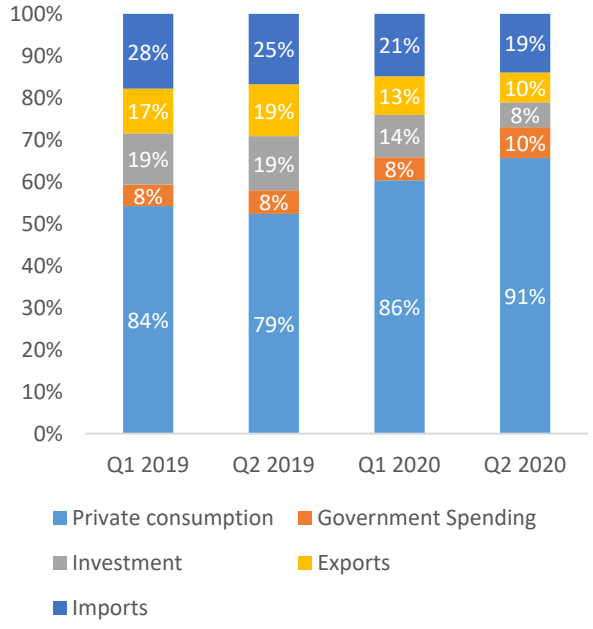


Source: World Development Indicators online dataset.

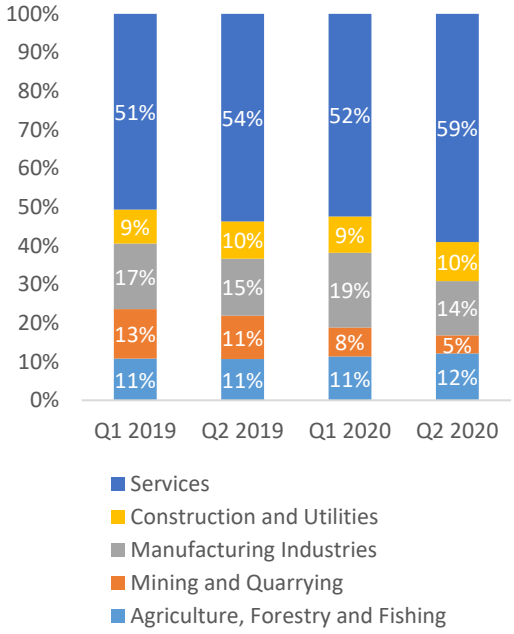
On a shorter term span, Figure 2 examines the different GDP components. At the demand level, the second quarter in Egypt (March-June 2020) experienced an increase of consumption to GDP from 79% in Q2-2019 to 91% in Q2-2020. This upsurge in private consumption was supported by the increase in remittances, social protection spending, cash transfers to irregular workers, low inflation and interest rate cuts. Government spending increased also from 8 to 10%. Yet, other components, namely investment, exports and imports decreased over the same period of interest (panel a). At the sectoral level, panel b shows that agriculture share to GDP increased slightly. One potential explanation of this trend could be due to the fact this sector is indispensable for food security and for providing population with their dietary needs. Conversely, the manufacturing sector share declined with the decrease in exports that decreased from 14% to 8% to GDP in Egypt. As per services, their share increased given that this sector includes information and telecommunication whose demand increased during the pandemic when schools, universities and work shifted to an online system.

Figure 2. Quarterly GDP composition in Egypt

(a) By demand components



(b) By sector



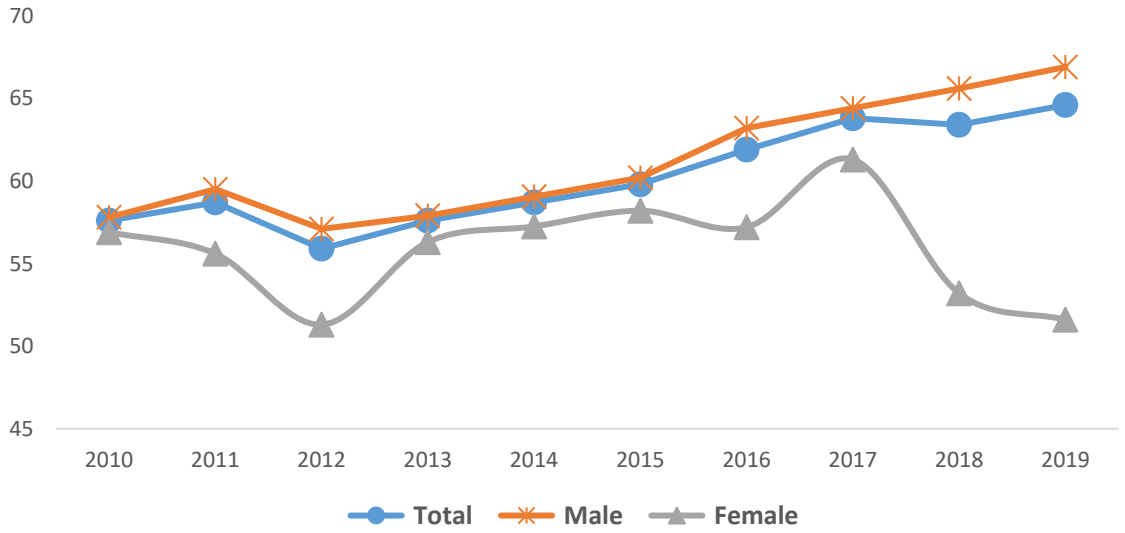
Source: Compiled by the authors from the Ministry of Planning and Economic Development in Egypt.

At the labor market level, informal labor[3] accounted for about 56.3% of non-agricultural employment in Egypt in 2019, compared with almost 47.2% in 2015. However, it accounted for over 64.6% of total employment in all sectors in 2019, compared with 59.8% in 2015. Two main reasons can explain this surge in informality. First, the Egyptian economy was unable to create enough jobs to accommodate new entrants to the labor market. Second, low standards of living

[3] The informal worker refers to anyone who works in an informal or formal establishment without a contract and/or social/health insurance (see Al-Mahdi, 2005).

have forced many families to send their children to work earlier. In fact, the informal sector acts always as a buffer helps mitigate recessions in the formal sector (such as the one of the pandemic). Yet, without health and social insurance, such a work is extremely vulnerable to any shock. Indeed, informality has upsurged due to this pandemic (World Bank, 2021b). Figure 3 shows that the percentage of total informal employment rose from 59.8% in 2015 to 64.6% in 2019. Over the same period, while the proportion of informal male employment increased from 60.2% to 66.9%, informal female employment fell from 58.2% to 51.6%.

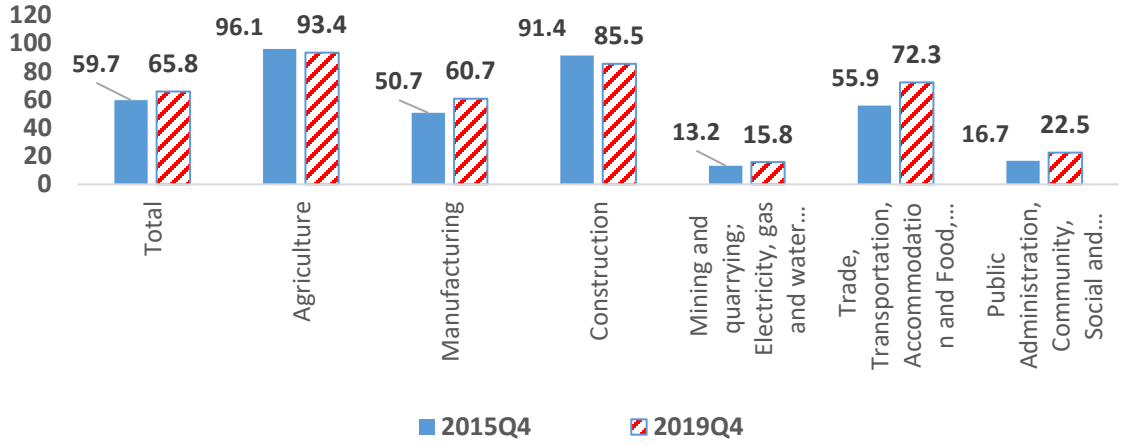
Figure 3. Proportion of informal employment in total employment by gender (%)



Source: ILO-STATISTICS, Informal economy - ILOSTAT

At the sectoral level, as shown in Figure 4, the highest share of informal employment in the fourth quarter in 2015 was in three major economic activities: agriculture (96.1%), construction (91.4%) and trade/transport (55.9%). While the proportion of informal labor in agriculture and construction declined in the fourth quarter of 2019 to 93.4% and 85.5%, respectively, it has increased substantially in trade and transport and manufacturing to reach 72.3% and 60.7%, respectively.

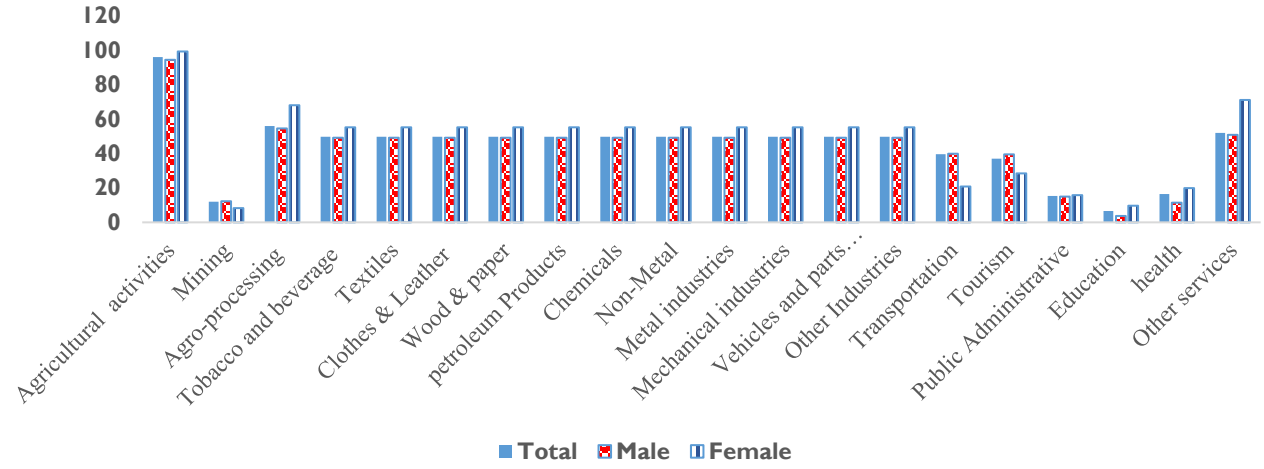
Figure 4. Informal employment rate by economic activity (%)



Source: ILO-STATISTICS, Informal economy - ILOSTAT

From a gender prospective, Figure 5 demonstrates that the percentage of women who work informally in agriculture, agro processing industries, and other services is considerably higher than that of men. The proportion of women employed informally compared to men in education and health was higher, reaching 9.7% and 19.9% compared with 3.7% and 11.4% respectively.

Figure 5. Informal employment rate in 2015 by sex and economic activity (%)

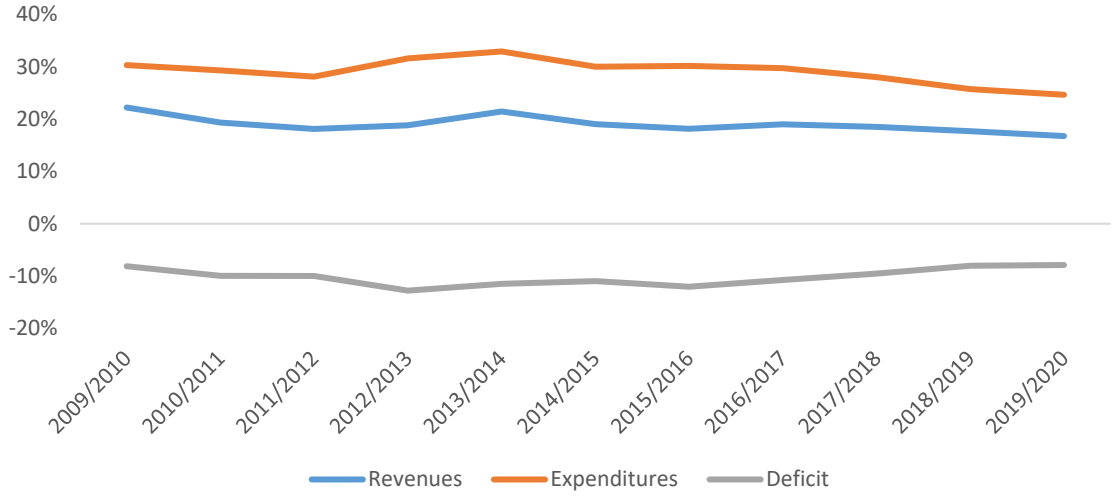


Source: ILO-STATISTICS , Informal economy - ILOSTAT

Against this background, most of the countries adopted fiscal stimulus programs and monetary measures in order to support their economies. The next part focuses on two important stabilization policies, namely fiscal and monetary ones. Figure 6 shows how revenues, expenditure, and fiscal deficits evolved over time. Generally, expansionary policies by either increasing public spending or providing tax exemptions or delays have been adopted. In Egypt, the government announced stimulus policies in the USD 6.13 billion package (EGP 100 billion, 1.8 percent of GDP). Yet, to support the government revenues, a Corona tax of 1% on all public and private sector salaries and

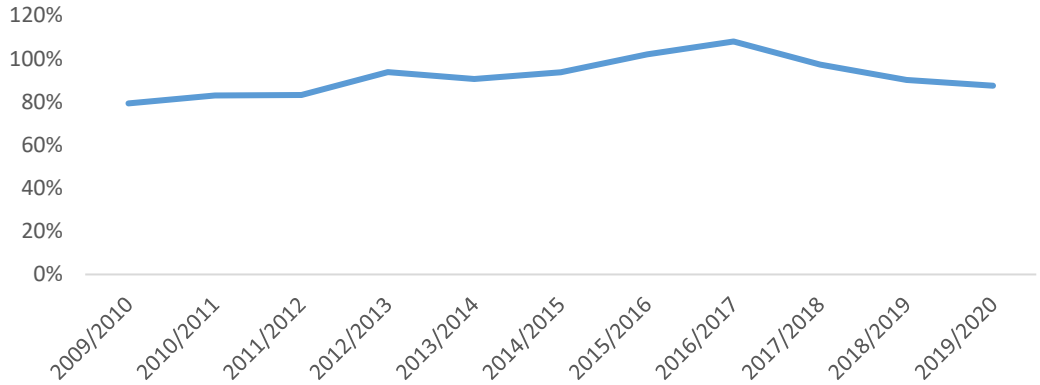
0.5% on state pensions have been imposed to support the sectors that are negatively affected by the pandemic. Thus, the fiscal deficit decreased slightly to reach 7.8% down from 8% in 2019. In addition, public debt decreased slightly from 90% to 88% over the same period, as shown in Figure 7. Yet, external debt increased significantly to reach 34.1% of GDP in the quarter of April-June 2020.

Figure 6. Evolution of revenues, expenditure and fiscal deficit



Source: Author's elaboration using fiscal data from the Ministry of Finance.

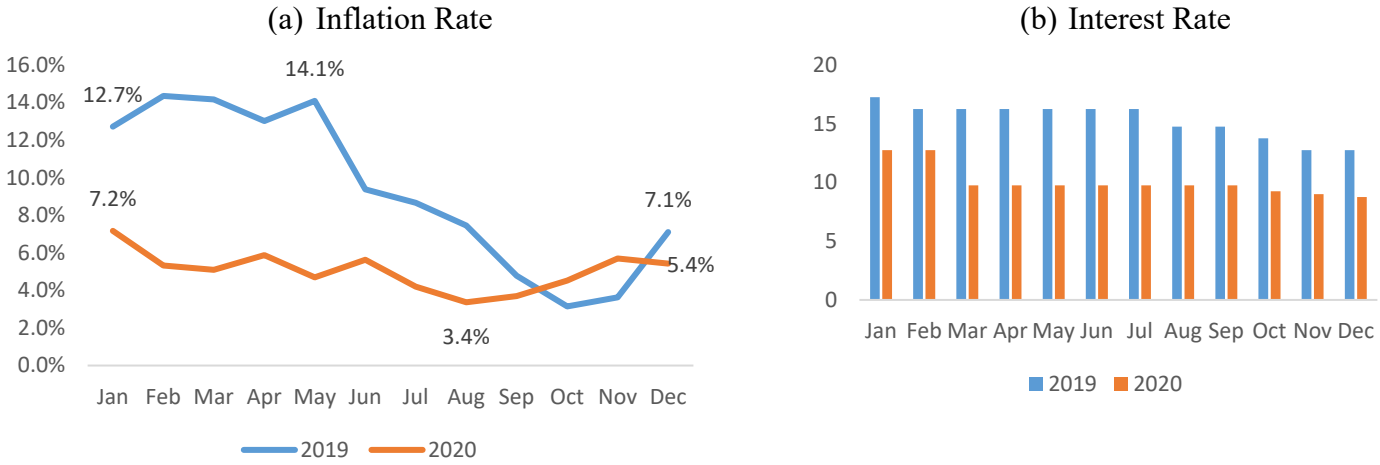
Figure 7. Evolution of Public Debt



Source: Author's elaboration using fiscal data from the Ministry of Finance.

After presenting the fiscal measures that have been implemented, it is important also to analyze the role of the Central Bank. Several measures were common to all countries such as the reduction in interest rates (see Figure 8b), introducing additional refinancing instruments, relaxing a timeframe for loan payments, loans deferrals, and postponing credit reimbursement by employees. The decrease in interest rate was feasible since inflation rates were generally lower in 2020 compared to 2019 (see Figure 8a).

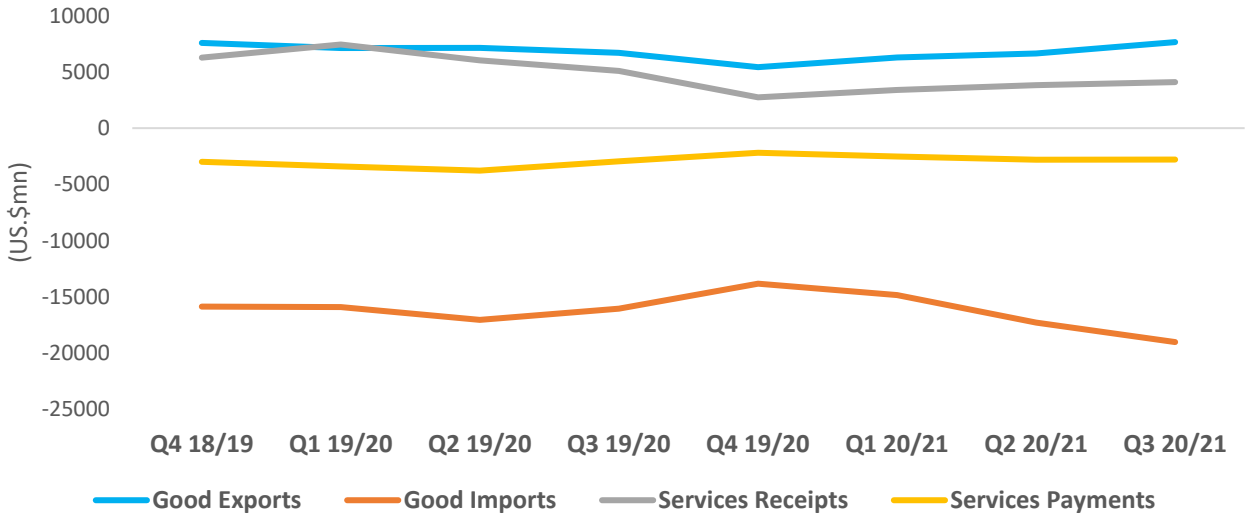
Figure 8. Inflation and Interest Rates, 2019-2020 (%)



Source: The Central Bank of Egypt.

At the external level, most of the sources of foreign currency decreased (exports, remittances, tourism, FDI, and Suez Canal revenues). Indeed, at the trade level, all countries experienced a significant decline in their exports during the first semester of 2020 compared to the first semester of 2019, especially moderately diversified economies such as Egypt that heavily rely on exports. Figure 9 shows that both goods and services exports have decreased by 19% and 46% respectively between the periods January-March 2020 and April-June 2020.

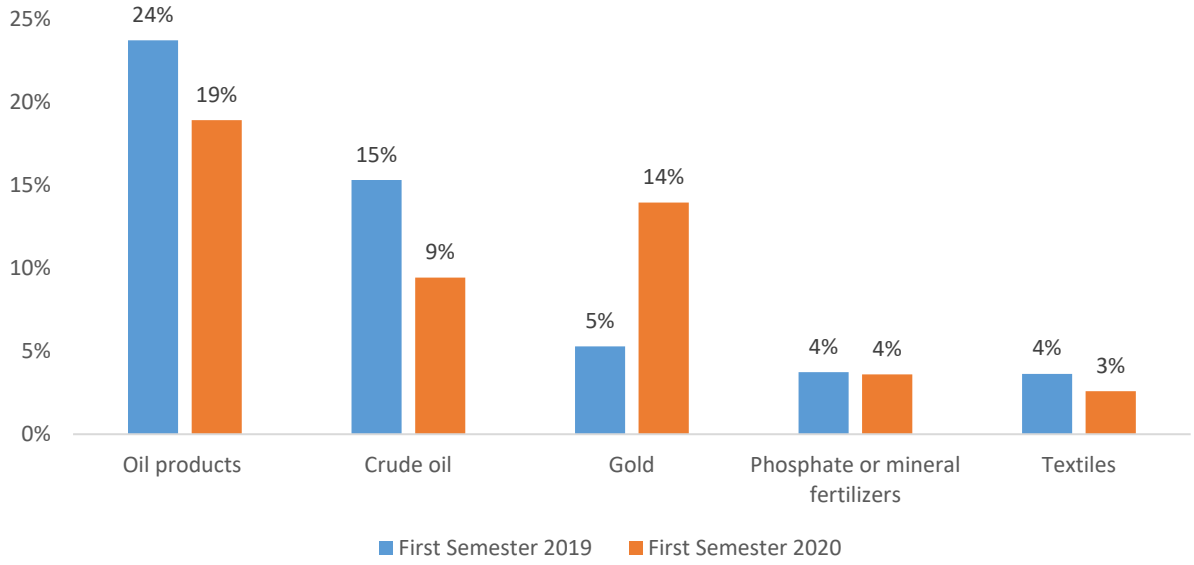
Figure 9. Exports and Imports of Goods and Services



Source: Central Bank of Egypt.

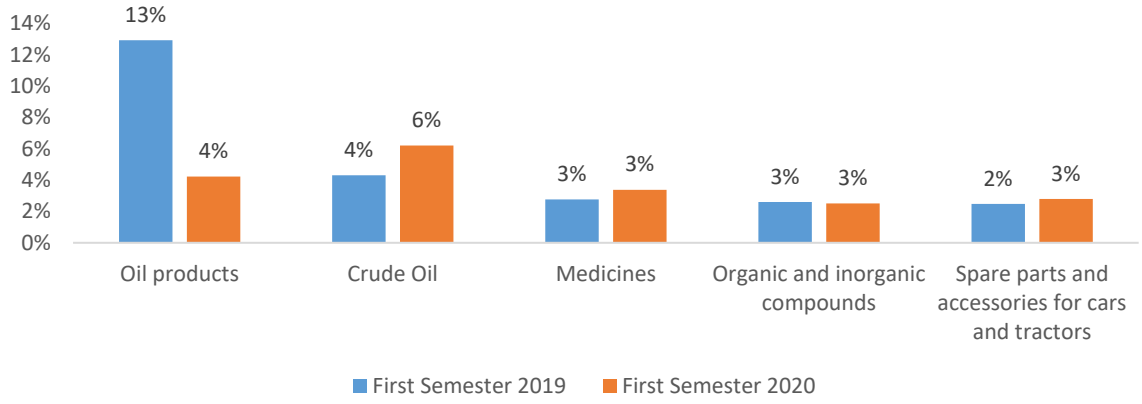
At the product level, Figures 10 and 11 shows that top products exported and imported by Egypt. Exports witnessed a significant decline in oil products, crude oil, and a slight one in textiles. In contrast, gold exports increased. At the imports level, Egypt's imports of oil and medicines have increased as shares to total imports (Figure 11).

Figure 10. Evolution of the main exported products by Egypt (share of total exports, %) 2019-2020



Source: Authors' elaboration using data from the Central Bank of Egypt.

Figure 11. Evolution of the main imported products by Egypt (share of total imports, %) 2019-2020



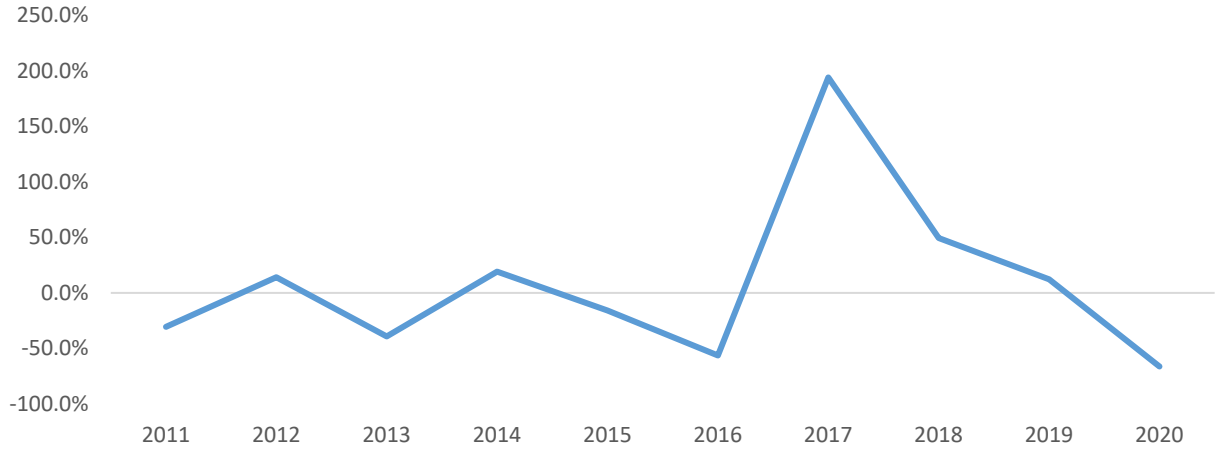
Source: Authors' elaboration using data from the Central Bank of Egypt.

The second source of foreign currency in Egypt is remittances. As the crisis was global and labor demand decreased at world level, the number of return migrants is likely to increase. Surprisingly, Egypt's remittances increased during this period. This is in line with some evidence one the important role of remittances in Egypt to promote consumption in periods of crisis (Helmy et al., 2020).

The third source of foreign currency in Egypt is tourism. Figure 12 shows a negative trend since tourism receipts decreased by 66.3% in Egypt between 2019 and 2020. This has been also reflected in the number of arrivals and the number of spent nights that decreased by more than 70% in Egypt

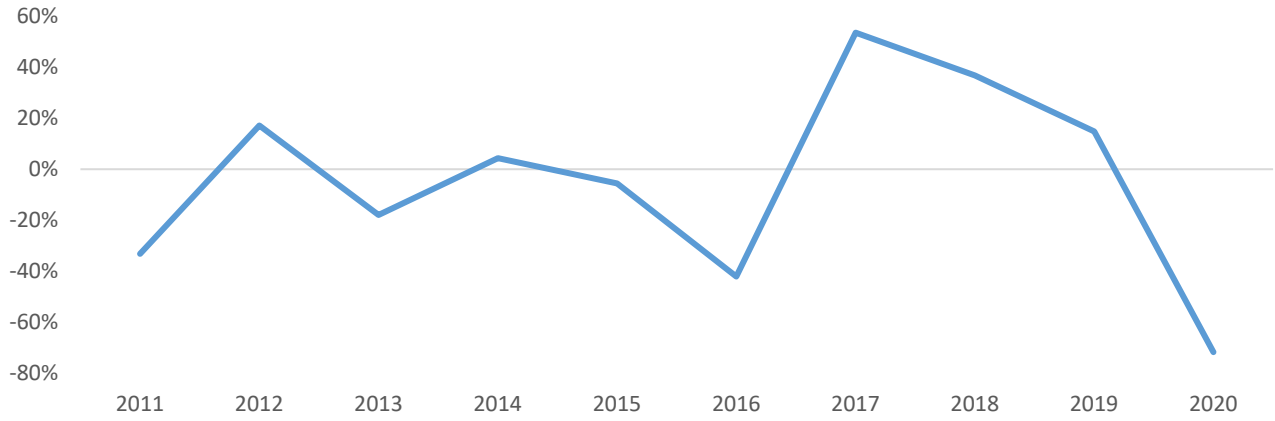
(Figures 13 and 14). As per Suez Canal revenues, they declined by 6% between the first two quarters of 2020 (April-June compared to January-March). FDI revenues experienced a severe decline by 63% during the first quarter of 2020 but increased by 57% in the second one to reach 1524 million USD up from 971 million USD.

Figure 12. Evolution of Tourism Receipts (%) 2011-2020



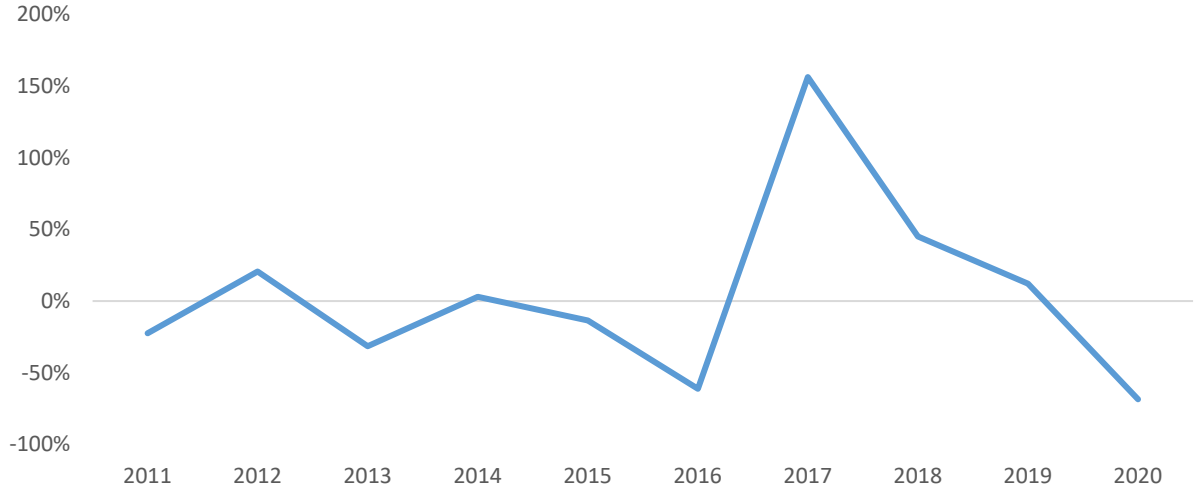
Source: Authors' elaboration using the datasets of the Central Bank of Egypt.

Figure 13. Evolution of Number of Arrivals (%) 2011-2020



Source: Authors' elaboration using data from CAPMAS.

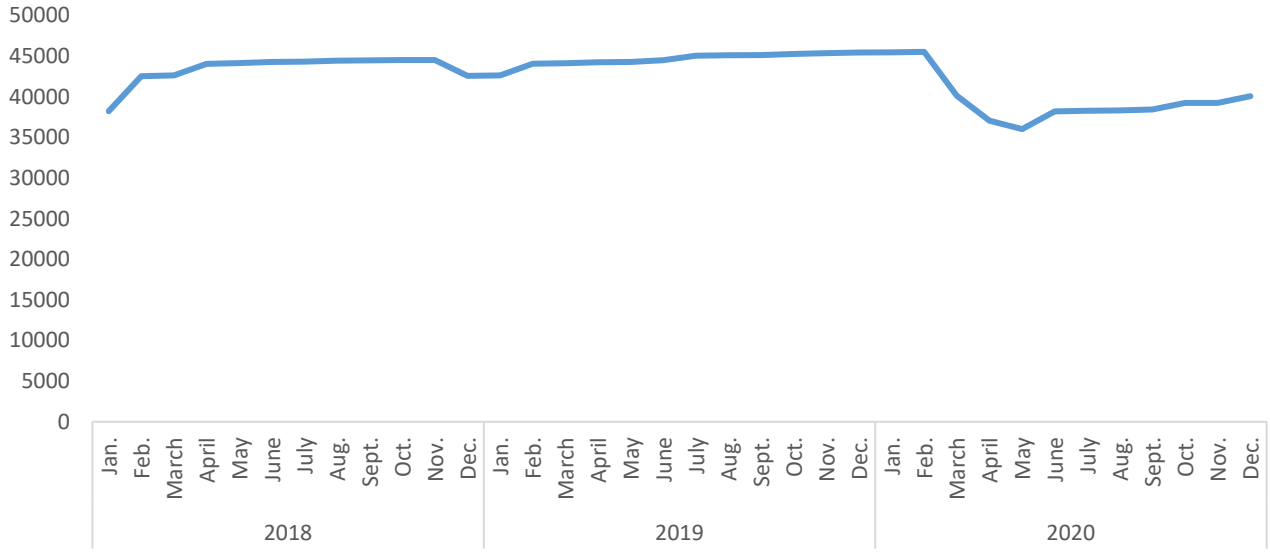
Figure 14. Evolution of Number of Nights Spent by Tourists (%) 2011-2020



Source: Authors' elaboration using data from CAPMAS for Egypt.

As a consequence of these development, international reserves declined from 40 billion USD in March 2020 to 37 billion USD in April 2020 (Figure 15). Yet, the exchange rate was rather stabilized by the Central Bank of Egypt despite these developments (Figure 16a). In contrast, the real effective exchange rate depreciated slightly by 2.5% between March and June 2020 (Figure 16b).

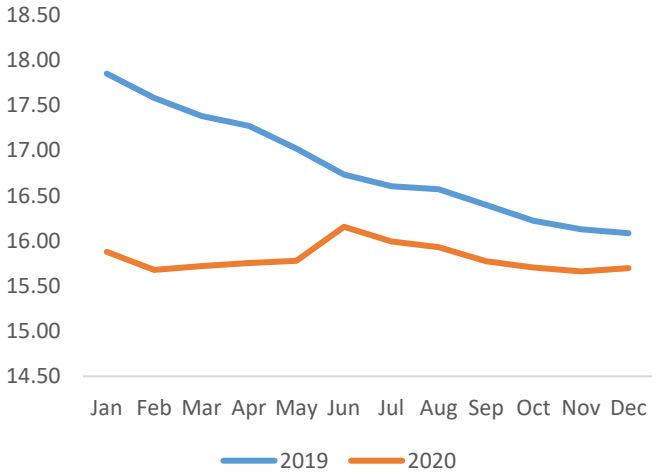
Figure 15. Evolution of International Reserves



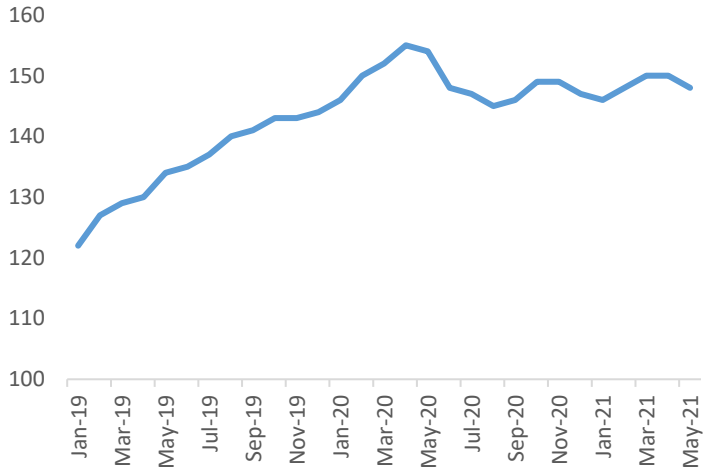
Source: Central Bank of Egypt.

Figure 16. Exchange Rates, 2019-2020 (%)

a) Nominal Exchange Rate



b) Real Effective Exchange Rate



Source: The nominal exchange rate comes from the Central Bank of Egypt. The Real Effective Exchange Rate (REER) comes from Darvas (2012) from Bruegel Institute.
Note: For REER: an increase in the index indicates appreciation of the home currency against the basket of trading partners' currencies

In a nutshell, this previous section shows how the Egyptian economy has been relatively vulnerable to the pandemic through the foreign currency channels (FDI, tourism, decrease in oil prices, Suez Canal revenues and exports). Yet, at the macroeconomic level, and despite these developments, it has been relatively resilient with positive economic growth rates supported by positive private consumption and public investment. The next section, using a CGE model, examines what are the direct and indirect effects of these different shocks and how the policy response managed to curb the negative impact of the pandemic.

4. Methodology

In order to examine the various effects of COVID-19 outbreak and the policy response, we employ a recursive dynamic computable general equilibrium model for the Egyptian economy. This model is a modified version of the PEP1-t single-country recursive dynamic CGE that is developed by Decaluwé et al. (2013). This model has a perfect competitive framework where producers are price takers in both goods and factors' markets. While labor is fully employed and mobile across economic activities, capital is sector specific. Each activity exhibits a nested structure. While the first production level is a Leontief production function composed of value added and intermediate consumption, value added is specified by a constant elasticity of substitution (CES) function of labor and capital. There are three types of labor in the model: unskilled, semiskilled, and skilled labor. Each industry can produce multiple commodities, which are aggregated by a constant elasticity of transformation (CET) function between exports and the goods that are sold domestically.

Since the model is a recursive sequential dynamic one, households have a myopic behavior. In other words, households are perfectly foreseeing all prices (Cockburn et al., 2018). Their consumption of a commodity is a CES function of domestic and imported quantities. A representative household maximizes its utility subject to its income constraint. It allocates its income from various sources between saving and consumption represented by a linear-expenditure system (LES). The latter implies that there is a minimal level of consumption that does not depend on commodities' prices or the consumers' income (see Appendix 3).

Government in this model has four revenue sources: direct taxes on income of domestic non-governmental agents (households and firms); indirect taxes on domestically produced or imported commodities; custom duties on imports; and transfers from domestic and foreign agents. The government allocates those revenues among current expenditure, subsidizing production process, social transfers and savings. Both government spending and transfers to other agents are exogenous in this model. Our model has three closure rules. First, this model is a saving driven model. Second, public demand for commodities for investment represents a fixed fraction of total expenditure. Finally, current-account balance determines the amount of foreign savings.

We calibrate our model based on the 2014/2015 Egyptian SAM that is jointly constructed by the International Food Policy Research Institute (IFPRI) and Central Agency for Public Mobilization and Statistics (CAPMAS). The elasticity of substitution and transformation are taken from Lofgren (2001) and Annabi et al. (2006). Moreover, labor supply is assumed to grow at the same rate as Egypt's total population in year 2014/2015 that is estimated by CAPMAS. The nominal interest rate (11.8 percent) comes from the database of Central Bank of Egypt and the depreciation by activity comes from CAPMAS.

To examine the economy-wide effects of COVID-19 and the stimulus package provided by the Egyptian economy, we run two sets of simulations. The first one is dedicated to examine the macroeconomic and sectoral effects of the COVID-19 shock and the second one simulates the impact of the policy response adopted by the government. The first set includes the following simulations: the decrease in the sources of foreign currency (decrease in oil prices (OIL), tourism revenue (TOUR), and Suez Canal (TRANS) revenues). We also simulate the increase in remittances inflow (REM), the decrease in total labor supply (LS), the increase in informal labor by 25% (INF-LS) and the positive demand shock (CONS) as it has been explained before. As per the policy response, we investigate the effect of fiscal stimulus (by distinguishing between current and productive spending, GOVS1 and GOVS2), the changes in monetary policy (such as the decrease in interest rates IR), and the different cash transfers to household/firm (SOCH+SOCF), informal labor (INF-TR) and activities (SUBP). Table 1 summarizes the different simulations and explains how they are implemented.

To introduce informal labor, first, we modify the Egyptian SAM and split the labor account into formal and informal labor. In addition, we divide sectoral demand for labor into demand for informal and formal labor. To do this, we use ILO data for the percentage of informal employment by economic activity in 2015. Second, we make the necessary modification to the original PEP-t model to incorporate unemployment rather than assuming full employment of labor.

In fact, the basic idea of the dual labor market (formal/informal) introduced by Harris and Todaro in 1970 shows that, based on this hypothesis, wages in the informal sector adversely impacted by the unemployment rate as follows:

$$W_{INF,L} = (1- UN_t)W_{FOR,L}$$

where W_{inf} , W_{for} and UN refer to the wage level of the informal and formal labor and the unemployment rate, respectively. Indeed, the wage curve establishes a negative relation between the real wage and the unemployment rate as follows:

$$awc\ (UN)^{\xi} = \frac{AVW}{PIXCON}$$

where awc is a scale parameter in the wage curve, AVW and PIXCON refer to average wage and consumer price index. ξ is the elasticity of unemployment with respect to real wages (ξ=-0.10 based on Zaki (2013)). In this case, the equilibrium in labor market will be as follows:

$$\sum_j LD_{l,j,t} = LS_{l,t}\ (1 - UN_t)$$

Table 1. Simulations Summary

The simulation	The simulation	The shock
Supply Shocks	Oil	A 34 percent reduction of world price of oil
	REM	A 11 percent increase in remittances
	TOUR	A 22 percent fall in total production in tourism activities
	TRANS	A 8 percent fall in total production in transportation activities (Suez Canal duties)
	LS	A 25% reduction of labor supply due to the 90 days lockdown measures
	INF-LS	25% increase in informal labor due to the closure measures
Full Foreign Currency Shock	FCUR	This experiment examines the shock of almost all sources of foreign currency in Egypt
Demand Shock	CONS	This experiment assesses the impact of increasing private consumption by 7.2 % through examining a 7.2 decline in marginal propensity to save
Fiscal stimulus package	GOVS1	This experiment assesses the impact of 20 percent increase in gross current public spending
	GOVS2	This experiment assesses the impact of 20 percent increase in final demand of commodity i for public investment purposes
	SOCH+ SOCF	This experiment assesses the impact of 15 percent increase in governmental transfers to households/Firms
	INF-TR	Providing EGP 500 cash transfers to irregular workers
	SUBP	This experiment assesses the impact of 15 percent increase in government subsidies to production sector
Monetary stimulus package	IR	This experiment assesses the impact of interest rate cut to reach 9.25 percent in April 2021.

Source: Constructed by the authors.

5. Simulation Results

As it was mentioned before, the Egyptian economy was exposed to several external shocks during 2020, the most important of which were the repercussions of the COVID epidemic and the decline in global oil prices. Those shocks have affected the Egyptian economy through a series of supply and demand side shocks. First, most of Egypt's sources of foreign currency, namely tourism and Suez Canal revenues were negatively affected. Closure measures for three months have reduced total labor supply with an increase in informal labor. Yet, while lock down measures were associated with a drop in private consumption in most emerging economies, official data reported an increase in private consumption in Egypt supported by the increase in remittances inflow, social protection package, EGP 500 cash transfers to irregular workers, low inflation rates and the interest rate cut (World Bank, 2021b). Moreover, at the trade level, Egypt depends on imported petroleum products, which represented 17% of the total merchandise imports in 2018/2019 (pre-crisis). At the same time, according to CBE database, the Egyptian crude oil exports represented nearly 41% of total merchandise exports in 2018/2019. This is why it is important to examine the impact of oil prices that are likely to affect both exports and imports. In this section, we analyze the effect of each shock on its own then quantifies the macroeconomic and sectoral effects of these combined simulations.

5.1. Supply and Demand Shocks by COVID-19

Fall in World Oil Price (OIL)

Brent oil prices declined by 34 % to reach USD 42 per barrel in 2020 compared to more than USD 64 in 2019 (World Bank, 2021). This decline can be explained by two main reasons: first, the decreasing global demand in several sectors as transportation and manufacturing because of the pandemic; second, the conflict between the Organization of the Petroleum Exporting Countries (OPEC) and Russia about the production policies. Thus, we simulate the impact of this shock in two ways: first, we simulate the fall of world import price of petroleum products (PWM) given that Egypt is a net importer of oil. Moreover, we simulate the fall in both import and export prices of petroleum products (PWM+PWX) since Egypt exports oil as well (41% of Egypt's total merchandise exports). Tables 2, 4, and 5 compare the macro, household level and sectoral effects of those two shocks. We focus on the second experiment, being more appropriate, in order to study the external vulnerability of Egyptian economy to world oil prices.

At the macro level, this shock reduces the consumer price index in short and long run by 0.82% and 0.02% respectively, which in turn increases private consumption by 0.33% and 0.02% over the same period. It also increases total investment expenditure by 0.14%. Thus, it has positive economic growth effect in both short and long run by 0.5% and 0.02%, respectively. Despite the increase in real GDP, the decline in oil price reduces labor demand in four sectors out of 20, namely agriculture (0.12%), mining (2.4%), petroleum (23.9%), and other services (0.5%). Given that more than 53 of total employment in the base year worked in these sectors, OIL shock leads to a reduction in total employment by 0.5% in the short run.

From a foreign trade perspective, this shock increases total imports by 1.9% thanks to lower oil prices, everything else held constant. It also decreases total exports by 0.3 % in the short run but over time, it has limited trade effects. Yet, the decline in imported oil prices leads to a decrease in export prices of all other products due to the decrease in production costs. The highest declines are in mining products (0.9%), vehicle (0.7%), and other industries (0.6%). Table 5 describes the heterogeneous sectoral effect of this shock on aggregate outputs. In fact, five economic activities out of twenty witness a decline in their aggregate output, namely agricultural activities, mining, clothes, petroleum, and other services. On the other hand, vehicles, non-metal, and metal industries enjoy a higher output growth rate by 1.4%, 0.7%, and 0.6%, respectively thanks to lower input prices as they are more energy intensive.

Concerning the welfare effects, the decline in world oil prices directly transmit to households through wages and output prices. Although they suffer from 0.54% decline in total disposable income, they enjoy a decline in consumer price index 0.84%. Since their welfare is measured by real disposable income deflated by the CPI, this shock leads to welfare gains to all the households' quantiles in both rural and urban areas. However, the primary beneficiary of this external shock is the richest quantile in urban area that are more likely to consume petroleum products compared to their rural counterparts. Table 4 shows the difference in welfare gains according to the geographical region and consumption quantiles.

Fall in Aggregate Output of Tourism Activities (TOUR)

Travel restrictions to eliminate the widespread of COVID-19 led to a slowdown of several economic activities, notably tourism-related activities. This shock can be treated as supply and demand one since closure measures increase the cost of producing tourism and reduce demand for tourism at the same time. According to CBE data, tourism revenues drop by around 22% in the FY 2019/2020 to reach USD 9.9 billion compared to USD 12.6 billion in the previous FY. Hence, we simulate a negative output[4] shock by 22% of tourism sector.

At the macro level, the simulation results show that COVID-19 shock to tourism activities is likely to have significant adverse effects on the whole economy. Real GDP is likely to be 0.3% and 0.2% lower than its level in business-as-usual scenario in both the short and long run respectively. Total household consumption slightly falls by 0.1% in the short term. Yet, over time, it is likely to increase by the same rate once the economy adjusts and the labor demand in this sector starts to increase again. This leads to a decline in several economic activities that are linked to the tourism sector through backward and forward linkage such as food, beverage, and transport activities. However, it is important to note that the massive decline in tourism revenue was associated with a depreciation of the real exchange rate and an enhancement in export competitiveness. Thus, total

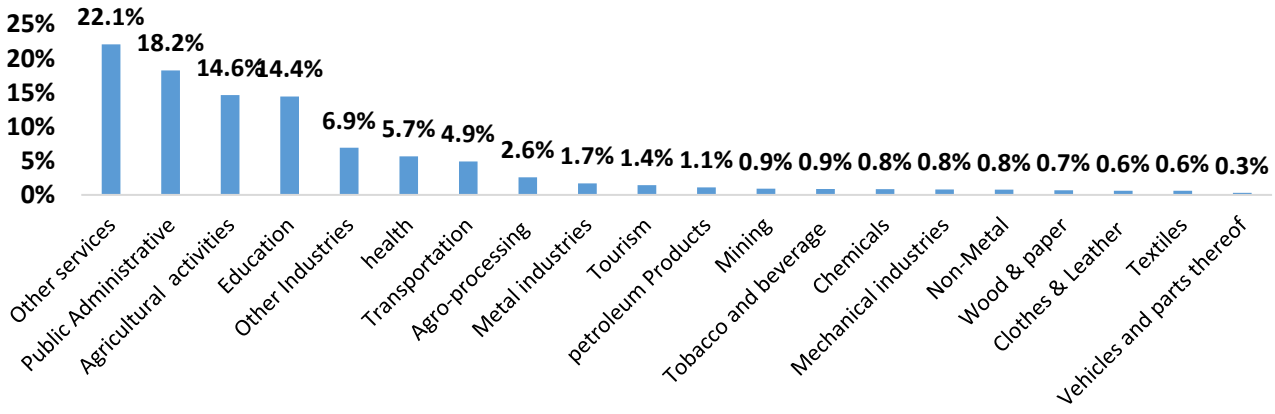
[4] To run this simulation, a closure rule to set aggregate output of tourism as an exogenous variable in the model.

exports increase by 14.6% especially from agriculture and vehicle sectors, whereas total imports increase by 2.8% leading to a decline in trade balance by 3.4%

Table (5) suggests that aggregate output of almost all non-tourist activities decline between 0.2% (petroleum products) and 19.6% (Tobacco and beverage). However, not all sectors will end up being negatively affected by this supply shock given that agricultural goods, vehicle, and other services sectors experience a slight increase. At the employment level, Figure 17 shows that these three activities employ approximately 37% of total employment. Yet around 61.5% of employment in agricultural activities is unskilled labor compared to only 26% in other services activities. Bearing in mind that more than 70 % of employment in tourism activity is unskilled and semi-skilled labor, the decline in tourism output leads to a reallocation of unskilled labor from tourism to the agricultural and other services activities.

At the household level, Table 4 shows that tourism shock deteriorates welfare of urban households especially the top quantile who heavily relies on capital income and tourism activities. Yet, rural households, especially the poorest two quantiles, whose main source of income is agriculture activities, witness on average welfare gains of 0.5%, compared to the business as usual (BAU) scenario.

Figure 17. Distribution of Employment, by sector



Source: Authors' calculation based on 2014/2015 SAM.

Fall in Aggregate Output of Transportation Activities (TRANS)

The transportation activities sector (Suez Canal), being one of the most vulnerable sectors exposed to the COVID-19 pandemic, experienced a sharp decline in its output. It is considered to have more forward and backward linkages with other sectors than tourism, which explains why both the supply and demand sides were affected. The closure measures that imposed restrictions on movement of people and goods reduce the supply of transportation services, which, in turn, increase transportation cost and adversely affects both domestic and foreign trade. On the other hand, it slows down the growth of manufacturing activities, which leads to a decline in the demand

for transportation activities. According to CBE, transportation revenues (of which primarily Suez Canal) dropped by around 8% in the FY 2019/2020 to reach USD 7.9 billion compared to USD 8.6 billion in the previous FY. Hence, we simulate a negative shock by 8% in aggregate output[5] of transportation activities.

Simulation results show that higher transportation costs lead to higher costs of inputs and final goods' prices and consequently fall in total private consumption by 0.54%. This leads to a decrease in production of 17 out of 20 activities, with the highest loss in transportation activity itself (see Table 5). This shock worsens the competitiveness of the Egyptian exports and result in a fall of total exports supply in both short and long run by 0.4% and 0.1, respectively. Moreover, it negatively affects total investment by 1.8 % in the short run. Hence, this supply shock reduces economic growth by 1% and 0.4% in short and long run, respectively compared to its BAU levels, *ceteris paribus*. In terms of welfare, this shock deteriorates welfare of all households in both rural and urban with heterogeneous magnitude that varies based on their income source and occupation. However, it decreases the welfare of urban households (especially the richest quantile) relatively more.

Increase in Remittances (REM)

According to CBE database, remittances revenues increased by around 11% in the FY 2019/2020 to reach USD 27.8 billion compared to USD 25.2 billion in the previous FY. Hence, we simulate the increase of transfers from the rest of the world to households' sector by 11% in the first year. It is worthy to note that the impact of remittances on economic growth is a function of how they are used since they can be used to finance household spending and/or capital formation reducing the savings gap.

Table 2 shows that increasing remittances boosts economic growth especially in the long run given that real GDP is higher than business as usual scenario by 0.5% and 2% in short and long run, respectively. This growth effect is due to the increase in private consumption (0.98%) and total investment (6.4%) that represents around 80% and 16% of GDP in Egypt, respectively (see Table A2.1). This is in line with the findings of Helmy et al. (2020) who argue that, in Egypt, there is a significant consumption smoothing effect of remittances, which in turn increases consumer price index by 2.5% and 1.2 % in short and long run. Thus, labor demand increases by 1% in the short run and 1.2% in the long run.

At households' level, increasing remittances by 11% increases household disposable income. Yet, it increases the disposable income in rural areas by 4% compared to 3.5% in urban areas. As the share of remittances in household income is relatively smaller in urban areas than in rural ones (see Table 6), a positive shock to remittances will be associated with a higher income effect in

[5] To run this simulation, a closure rule to set aggregate output of tourism as an exogenous variable in the model.

rural areas compared to urban ones. However, Table 4 suggests that welfare gain in urban areas is higher than rural ones due to an increase in prices in the latter with a stronger demand.

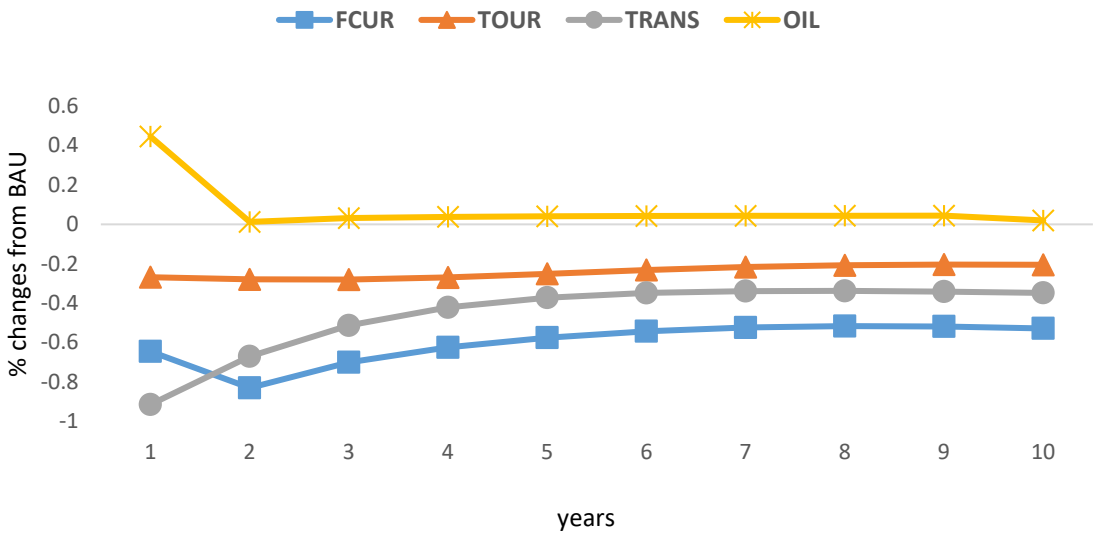
From a sector perspective, a massive inflow of foreign exchange is associated with an appreciation of the real exchange rate and a deterioration in export competitiveness (see Table 2). While it decreases total exports by 2.1% and 0.65% in the short and long term, it increases total imports by 3.4% and 4.7% respectively. The largest decline in exports is in agriculture, petroleum, and chemicals. At the same time, the sectors that record the highest increase in imports are vehicles, agriculture, and mechanics. Indeed, the increase in remittance flows adversely affects domestic production, particularly domestic production of tradeable goods. The simulation results show a decrease in aggregate production in 8 out of 20 sectors, including mechanical, textile and agricultural, with the largest decline is in production of agricultural products.

Combined Foreign Currency Shocks (FCUR)

To assess the direction and the magnitude of the implications of the external shock of the Egyptian sources of foreign currency, we did a combined simulation in which we simultaneously simulate the decline of oil prices by 34%, the cut in tourism and transportation services output by 22% and 8%, respectively.

Simulation results show that the pandemic decreases real gross domestic product by 0.3% (TOUR) and 0.9% (TRANS) but the shock of oil price (OIL) increases economic growth by 0.45% and compensates for the negative effects of the COVID-related shocks. Figure 18 and Table 2 show that the combined shock to the sources of foreign currency (FCUR) leads to a decline in real GDP by 0.6%. Under this combined scenario, total private consumption is likely to rise by 0.2% in the short run. In addition, the negative effects of the pandemic on export and investment are attenuated thanks to lower oil prices. From the income perspective, it leads to positive households' disposable and firm incomes, which, in turn, increases government income due to the increase in its income from direct tax. Table 5 suggests that aggregate output of all non-agricultural activities decline between 0.1% (mining products) and 21.2% (Tobacco and beverage). Concerning the welfare effect of this shock, it is worth mentioning that the welfare impact is much more heterogeneous compared to the individual shocks. Welfare of middle consumption quantiles in both rural and urban deteriorates by 0.3% and 0.8%, respectively. This can be explained by their consumption pattern that is chiefly concentrated in the crisis-affected services, compared to food products in the poorest quantiles (see Figure A2.3).

Figure 18. The Economic Growth Effects of COVID-19 and Oil Prices Shocks

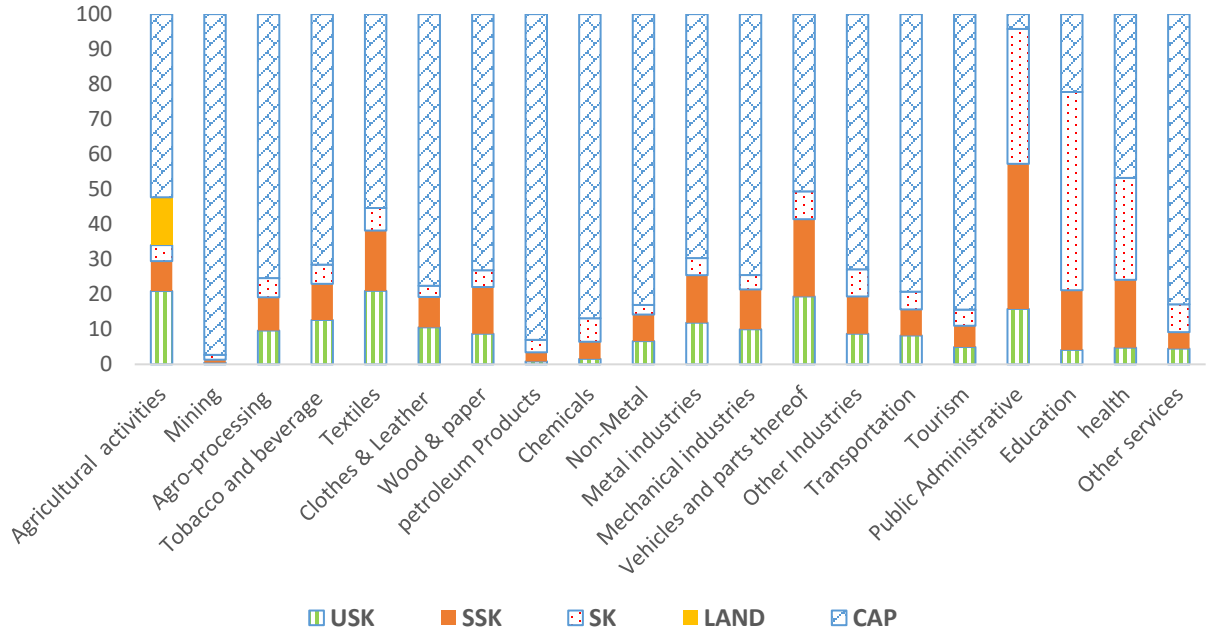


Source: Authors' elaboration based on simulations result.

Reduction in labor supply (LS)

Lockdown measures for 90 days forced more than 25% of labor to work from home. Yet, this option was not available for unskilled labor who is more likely to lose his job. This simulation examines the impacts of this supply shock across all sectors in 2020. At the macroeconomic level, simulation results suggest that, with the absence of policy interventions, this shock adversely affects economic growth in both the short and long run. Indeed, GDP would be permanently 6.2% lower than business as usual scenario in the long run due to its long-lasting negative consumption effect (5.5%). The decline in private consumption is associated to an increase in consumer price index by 7.7% due to the significant rise in wages by 31.5%. Although this shock is related to labor supply, return to capital witnesses an increase by 5.1%, as production activities use both labor and capital, with different ratios, to produce goods and services. At the sectoral level, aggregate output is expected to record a loss of 8.3%. However, labor-intensive, and tradable sectors are more likely to suffer (such as public administration, education, textile, and health, see Table 5 and Figure 19).

Figure 19. Distribution of Value-Added for each Activity



Source: Authors' calculations from 2014/2015 SAM.
Notes: USK: unskilled labor, SSK: semi-skilled labor, SK: skilled labor, Cap: capital.

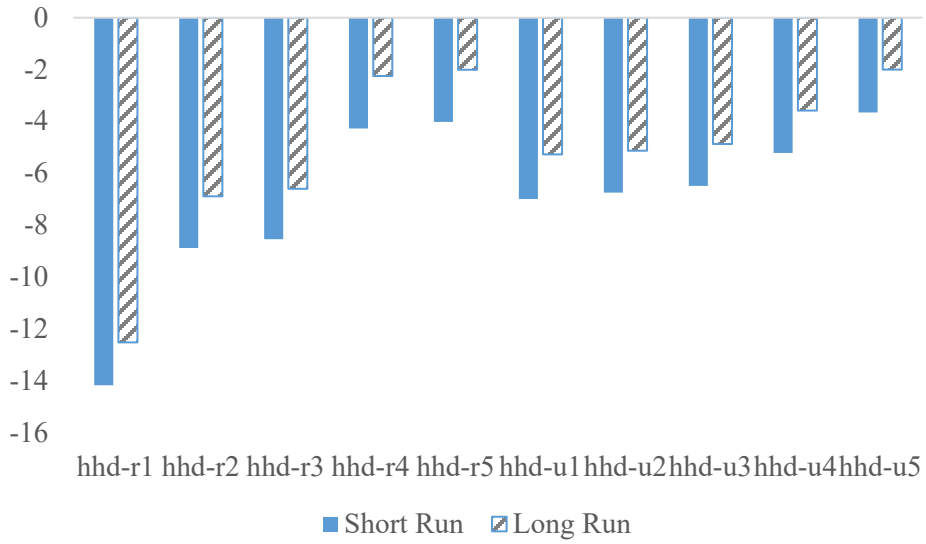
From a welfare perspective, this shock affects households' income and welfare in a heterogenous way depending on their source of income and the nature of work (formal/Informal). Indeed, the poorest rural households suffer from welfare loss three times more than the poorest one in urban areas. The poorest rural households are the most affected group because of their source of income and the high share of labor informality. Indeed, they heavily depend on agricultural activities or manage their own business.

Increase in informal labor supply (INF-LS)

Overall, the closure measures for 90 days to eliminate the spread of COVID-19 had two negative effects. First, it reduced demand on exports, which in turn pushed total output and labor demand down. Second, it drove up the cost of domestic transportation and international trade. Thus, enterprises tend to replace their formal workers with informal ones in order to reduce their costs, which in turn could increase informality. Moreover, with the increase in unemployment, the informal sector represents a buffer when the formal sector is affected by a crisis. Thus, we simulate an increase in informal labor by 25%, proportionally to the decrease in labor supply that was presented above. Since there is no available data related to informal workers in 2020, we rely on data from the ILO that show that informal workers accounted for more than two thirds of the Egyptian total employment in 2015. Moreover, the World Bank (2021) refers to similar estimates related to the upsurge of informality in Egypt due to COVID -19 pandemic in its latest update issued in April.

The 25% increase in informal labor is associated with an increase in unemployment rate that increases to 17% compared up from 13.1% in benchmark year. Thus, wages of both formal and informal workers fall by 2.9% and 9.6%, respectively. In general, composite wage rates fall in all economic activities except education and mining. The biggest decreases in wages occurred in agriculture (11%) and other services (7.5%). Indeed, simulation results show that the disposable income of all households' quantiles in both rural and urban areas decreases significantly. However, rural households experience greater income losses. Figure 20 displays the effects of this shock on households' disposable income in the short versa long term.

Figure 20. The Effect of 25% Increase in Informal Labor Supply on Household income (%)



Source: Authors' elaboration based on simulation results.

The decline in wage rates encourages activities to increase labor demand by 17.5% (informal work) and reducing demand on formal labor by 5.9%. Indeed, total output of all activities increases between 0.3% (education) and 7.8% (agriculture), as shown in table 5. Given that unemployment rate increases, this leads to a reduction in the consumer price index of 3.2% and 3.7% in the short and long term, respectively. This confirms Philips curve hypothesis in which the higher the level of unemployment, the lower the equilibrium wage. Similarly, FOB prices for exported products fall, on average, by 2.2%. As a result, demand for exports increases in nearly all activities, with agriculture (17%), agri-processing (7.6%) and textiles (5.4%) accounting for the largest increases. Moreover, total private consumption increases by 2.5% and 3.2% over the short and long term, respectively. Thus, this shock increases real economic growth in the short and long run by 1.9% and 2.7% (see Table 2). This may partially explain why Egypt is less affected by COVID-19 compared to other counties in the MENA region.

From welfare prospective, despite the decrease in disposable income, national welfare improves by 0.4% in short run thanks to a higher consumption and lower prices. However, this shock reduces

government income by 4.3%, which in turn lowers public social spending and negatively affects well-being in the longer term. In fact, the simulation results show that the household well-being gain in the poorest three rural quantiles is higher than in urban areas because of the concentration of informal employment in the rural areas, as it is shown in Table 4. It is important to note that, despite the improvement in some macroeconomic aggregates, the literature argues that shifting employment from formal to informal work leads to an undesirable work environment, as it worsens working conditions.

Increase in private consumption (CONS)

Closure measures and social distancing to prevent the spread of COVID-19 led to a decline of different components of final demand—households' consumption, investments and exports in both emerging and developed countries (McKibbin and Fernando, 2020). Indeed, households reduce their consumption in order to save and face uncertainty associated to their future income. Nonetheless, unlike most emerging economies, COVID-19 led to a positive increase of consumption in Egypt by 7.2% during the period (Jan-March) 2020 compared to the same period of the previous year, as reported by Ministry of finance[6]. There are five main reasons for this growth in private consumption: first, the increase in remittances inflow of 27.6% over the period (January-March) 2020 compared to the same period of the previous year; second, the increase in the social protection package of 8% in fiscal year 2019/2020 compared to the prior fiscal year; third, the Egyptian government provided irregular workers with EGP 500 cash transfers to mitigate the negative impacts of the pandemic; fourth, the decline in inflation rates to reach 5.1% in March 2020 versus 8.9% in 2019; finally, the monetary authority cut the interest rate from 17% in March 2019 to 12.7% in March 2020, as indicated in the Central Bank's statistics. To investigate the impact of this demand shock, we simulate the effects of temporarily increasing private consumption by 7.2% in 2020 through reducing marginal propensity to save with the same amount.

At the macroeconomic level, this shock is likely to increase total private consumption by 1.2% in the short run, which in turn stimulates short run economic growth by 0.6%. However, it hurts total investment due to its adverse effects on households' savings. Thus, over time this shock negatively affects economic growth (see Table 2). Indeed, consumption of all products increases but with various rates. Concerning the foreign trade impact of this shock, it decreases total exports by 0.4% and increases total imports by 0.1% as domestic producers find export market less profitable than domestic one. Therefore, this shock worsens trade balance. Yet, since it increases household and firm disposable incomes by 0.61% and 0.63% respectively, it increases government income due to the increase in both direct and indirect tax revenues.

The sectoral output effect of this demand shock is also heterogenous. Indeed, aggregate output in thirteen out of twenty activities increases but with different rates that range between 0.04% in

[6] Ministry of Finance (2021). The Financial Monthly. VOLUME 16. NO. 7. May

tourism activities to 1.1 % in tobacco and beverage (Table 5). Yet, the fall in exports of almost all products takes place especially in mechanical products, mining, and non-metal products by 0.5%, 0.45% and 0.42%, respectively. It is important to note that Egypt has a comparative advantage in these sectors, which exerts a negative effect on aggregate demand. As closure measures disrupt the global trade and supply chains, they negatively affect total labor demand in short run by 0.3%. The highest reduction in labor demand is within skilled labor by 0.5% compared to 0.35% for unskilled labor. Yet, as the increase in private consumption is concentrated in sectors that depend mainly on skilled rather than unskilled labor- or capital-intensive activity as vehicle, metal, non-metal, education, and health (see Figure 19), this negative employment effects vanishes in the long run due to the positive effect implied by the increase in private consumption.

From a welfare perspective, all households in rural and urban enjoy welfare gain with different magnitude. However, the primary beneficiary of this shock is the richest quantile in both rural (2.9%) and urban area (8.2%). Table 4 shows the difference in welfare gains according to the geographical region and consumption quantiles.

5.2. Fiscal and monetary stimulus package

As it was mentioned before, the Egyptian government has launched a comprehensive stimulus package that included some fiscal and monetary measures to mitigate the negative effects of COVID-19 crisis on major sources of economic growth. In fact, the Ministry of finance has provided higher number of tax exemptions, social safety net spending, and support measures for different sectors. For example, total public spending has increased by more than 19 percent to reach EGP1713 billion during the fiscal year FY20/21, compared to EGP1435 billion in the previous FY. However, the government has realized the importance of redirecting funding sources to more productive sectors as investment in human capital, social protection, and of ensuring a better distribution of services. Hence, the government has increased its spending on public investment, subsidies, grants, and social benefits by nearly 15 percent during the period April-June of FY20/21 compared to the same period in the previous FY. On the other hand, the Central Bank of Egypt has announced 43 percent cut in lending interest rate to reach 9.25 percent in April 2021 compared to its level in the FY19/20. This section investigates the effectiveness of public policy response to curb the negative impacts of COVID-19 pandemic on the Egyptian economy.

Increasing public Current spending (GOVS1)

We first simulate the impact of 20 percent increase in gross current public spending in line with what has been implemented by the government. This leads to an increase in the demand for factors of production, which increases wage and capital rent by 6.2% and 2.6%, respectively. Hence, households and firm disposable income increases by 3.6% and 2.3% respectively in the short run. Although this policy increases consumer price index by 3%, it increases private consumption by 0.6%. It also leads to increase in economic growth by 0.4% in the short run. Yet, increasing public spending by 20% to fight the pandemic substantially deteriorates the overall fiscal balance by 20%

and 26% in both short and long run, which in turn increases interest rates to 13.2% compared to 11.8% in business-as-usual scenario. Consequently, with a crowding out effect, this policy response reduces private investment by 10.7% in the short run and 18.9% in the longer term (see Table 3).

At the sectoral level, only three sectors benefit from this policy, namely public administration, education, and health services since their aggregate output increases by 10.6%, 6.4% and 2.5%, respectively. The other economic sectors are likely to suffer from lower aggregate output that ranges between 0.2% (agro-processing food and clothes and leather activities) and 9% (vehicles). Consequently, this policy leads to negative growth rate 3.4% in the long run. Moreover, this policy response negatively affects total employment by 4.9% and 6.5% in the short and long run, respectively. This can be explained by its adverse impacts on most labor-intensive activities especially other services and agricultural products (see Table 5).

At the welfare level, Table 4 describes the welfare impacts of this stimulus package. All households experience welfare gains in both urban and rural areas. However, this expenditure benefits the richest quantile in urban areas by 4% compared to 1.2% in the same quantile in the rural areas. Yet, it more than doubles welfare gain within the poorest two quantiles in rural area compared to urban ones, highlighting the importance of such policies from a social perspective. All households witness welfare gains due to the increase in their average disposable income by 5.3%.

Overall, increasing public current consumption without sectoral targeting has only positive welfare effects but it hurts economic growth and employment Moreover, it is not sufficient economic growth in the long run. In addition, it worsens trade balance through reducing total exports by 2.2% (because of the crowding out effect that reduces investment and production) and increasing total imports by 0.1% in the short run. Such a trade balance deteriorates even more in the long run.

Increasing public investment spending (GOVS2)

We replicate the previous simulation but instead of increasing public spending on consumption, we increase public investment by 20% to curb the negative effect of the pandemic. This simulation leads to a slight increase in total consumption by 0.02% and total exports by 0.12%. Thus, it increases real GDP by 0.5% in the short run. However, it adversely affects private investment, which leads to a decrease in long run economic growth rate by 0.05% (see Table 3). Unlike GOVS1, this policy response increases total employment in both short and long run by 0.4%, with the highest increase in labor demand is in vehicle industries (1.3%) and other industry sector, including construction and public utilities (1.1%) compared to BAU employment.

At the sectoral level, all production activities, except agricultural and other services, witness a positive aggregate output that ranges between 0.01% in mining activities and 0.6% in vehicle

industries. Concerning its effects on sectoral foreign trade, this policy increases exports of 15 out 20 sectors. Despite the decline in its aggregate output, exports of agricultural products are likely to increase by 0.68% in the short run compared to its level in BAU scenario. This means that domestic producers of agricultural redirect their production to the export market, which becomes more profitable than the domestic one. Thus, when GOVS1 and GOVS2 are compared, it seems that the latter yields more positive effects than the former pointing out the externalities generated by public investments and their positive effects on economic growth at the macroeconomic level (Barro, 1990).

At the social level, GOVS2 leads to welfare gains to almost all households in both urban and rural areas, except in the richest quantile in rural areas. Yet, it yields a lower welfare gain compared to GOVS1. Labor demand in rural sectors declines, which can explain the ineffectiveness of public investment policy especially in this area as shown in Table 4 since it reduces labor demand in agricultural activities in both the short and long run by 1.2 % and 1%, respectively. This pushes wages and hence total households' disposable income by 0.2% and 0.16%, respectively. Thus, a more tailored policy is needed to address specificities of rural areas when it comes to public investment.

Increasing public transfers to households and firms (SOCH+ SOCF)

This experiment investigates the effectiveness of increasing social transfers to households and domestic business agents to enhance economic recovery. Table 3 shows that GDP is likely to be lower than the baseline scenario by 0.2% and 2.7% in the short and long run, respectively. Indeed, this policy response succeeds to increase private consumption by 1.5% in the short run. Yet, it has an adverse effect on private investment, which is likely to decline by 8% and 16.5% in short and long run, respectively since it decreases the available resources allocated to other more productive sectors such as public utilities, construction, and public administration activities. Concerning its employment effects, it reduces total labor demand by 0.5% and 1.8% in the short and long run, respectively. At the sectoral level, it yields heterogenous output impacts since it increases aggregate output of fourteen out of twenty activities between 0.1% (tourism) and 1.5% (tobacco and beverage). On the other hand, it reduces aggregate outputs in six sectors, the highest decline in vehicles and parts thereof by 5.6% (see Table 5). Concerning its sectoral foreign trade effects, simulation results suggest that thirteen activities reduce their exports between 0.3% (textiles) and 1.3% (vehicles) as the domestic market become more profitable than export one thanks to consumers whose domestic demand increases with higher social transfers.

Consequently, from a welfare and distribution perspective, simulation results suggest that this stimulus policy is likely to be regressive. In fact, the richest gain the most across the rural (3.3%) and the urban households (11.7) compared to the bottom quantiles in both areas (see Table 4) since transfers from the government to the richest households in urban areas represent 7.2% compared to only 2.8% of total income of the poorest households in rural area (see Table 6). Thus, without

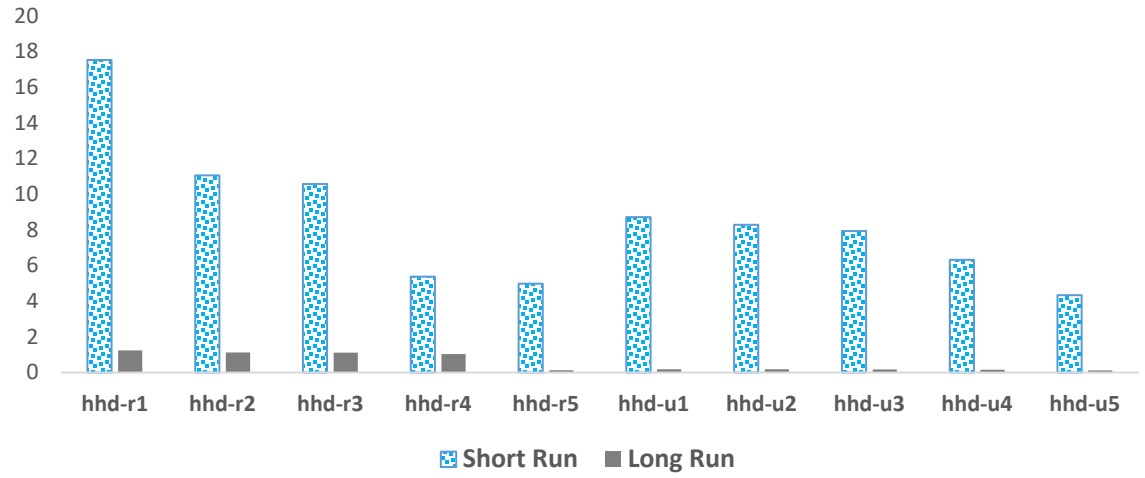
more targeted policies, public transfers are likely to worsen income distribution, foreign trade balance and yield adverse employment and growth effects.

Cash transfers to informal labor (TR-INF)

According to the ILO (2021), the COVID-19 pandemic has resulted in wage losses for more than two-thirds of informal and self-employed workers, compared to 21% of formal wage earners. In fact, the Government of Egypt has taken several actions to mitigate the negative impact of COVID-19 on vulnerable groups who have been hit by COVID-19, particularly irregular workers. Thus, the government has provided these workers with EGP 500 monthly cash transfers. To simulate the effects of this shift, we modelled it as a negative 16% payroll tax (or a positive subsidy) on informal labor.

The simulation results suggest that cash transfers to informal workers increase disposable income for all households in urban and rural areas. However, it appears that the increase in the incomes of the lower quintiles in rural areas increases more than their counterparts in urban areas. Yet, these gains disappear in the long run, as shown in Figure 21.

Figure 21. The Effect of providing EGP500 to irregular workers on their income (%)



Source: Authors' elaboration based on simulation results.

Total disposable income of households increases by 7% and 0.1% in the short and long run, respectively. This pushes up total private consumption of goods and services by 9.5% in the short run. The increase in private consumption leads to a rise in the consumer price index of 1.93% and 0.57% in the short and long term respectively. Although informal labor income accounts for almost 47% of total household labor income, the increase in household income leads to an increase domestic demand for goods and services.

On the other hand, this transfer negatively affects public investment (2.2%) as it increases its budget deficit by 12.5% leading to a crowding-out effect with the increase in interest rate from its

benchmark level (11.8%) to 13%. Therefore, total investment expenditure decreases by 4.97%. This leads to a drop in aggregate output by 0.37% in the short run, mainly in the production of seven sectors such as vehicles (11.1%), other industries (4.8%) and metals (3.6%), as shown in Table 5. In contrast, the demand for labor rises by 1.97% due to the increase in the production of some sectors that are labor intensive such as agro-processing, beverages, and textiles. This results in an increase in wages by 1.22%.

With regard to foreign trade, the simulation results show that the average FOB price of exported products increased by 0.74% with the highest increase is in export prices for vehicles by 1.8% and other services by 1.5%. This reduces export demand by 1.12% and 0.96% over the short and long term. Meanwhile, it slightly increases imports by 0.14% in the short term and decreases them in the long term, as shown in Table (3). Consequently, real GDP at market prices fell by 0.43% and by 0.56% in the short and long term. This fall in real GDP is a result of the decline in total investment, net exports, and government spending.

From welfare perspective, Table 4 indicates that all households in rural and urban witness welfare gains from these transfers. Yet, the principal beneficiaries of such cash transfers are the three poorest classes in rural areas and the richest class in urban areas. This may be due to the concentration of irregular employment and self-employed workers in those segments.

Increasing public subsidies to production activities (SUBP)

The Egyptian government introduced other fiscal measures to reduce the severity of COVID-19 crisis for production activities such as tax breaks, extending deadline to pay taxes, and a deferral to pay customs duties. This section treats those measures as a production subsidy where the government increases by 15% production subsidies. Table 3 suggests a decline in production costs, which reduces consumer price index by 0.21%. This leads to an increase in private consumption by 0.74% in the short run. Moreover, it increases, though artificially, the competitiveness of Egyptian exports that are likely to increase by 0.2% in the short run. Consequently, it increases total labor demand by 0.3%, which rises wages by 0.55% and 0.1% in both the short and long run, respectively. Thus, this policy response is likely to increase both households and firm disposable income by 0.5% and 0.6% respectively. Those entire macroeconomic effects increase GDP growth rate in the short run by 0.9%. However, it decreases the available resources to other more productive fiscal functions and leads to a negative long run growth rate by 0.2%.

At the sectoral level, domestic producers adjust their aggregate output to the lower cost of production. Table 5 shows that twelve out of twenty activities increase their aggregate output between 0.02% (other services) and 0.88% (agro-processing products). However, it is likely to lower aggregate output in other industries (including public utilities and construction) by 1.1% and vehicle by 3.2%. With lower costs and higher purchasing power, domestic producer in fourteen activities redirect their exports to the domestic market, which becomes more profitable especially

in petroleum (1.1%) and agricultural products (0.6%). On the other hand, the highest increase in exports is in mechanical, metal, and non-metal products. Furthermore, this policy is likely to reduce more imports of vehicle by 3.7% and mechanical by 3.6%.

In terms of welfare, this policy response leads to similar welfare impacts on the bottom rural households as in ***SOCH+ SOCF*** experiment. Yet, it is likely to be less regressive in the top quantiles in both rural and urban. Thus, it enhances income distribution compared to simple cash transfers.

Interest Rate Cut (IR)

Aiming at easing short-term liquidity for firms and reducing the severity of COVID-19 crisis, the CBE reduced interest rate to reach 9.25 % in April 2021 compared to more than 13% in the FY19/20. This simulation examines the macro, sectoral and household level impacts of reducing interest rate from 11.8 % in base year (BAU scenario including the SAM data) to 9.25%.

Table 3 describes the macroeconomic effects of this policy. The reduction in the interest rate reduces the cost of investment and production, which leads to an increase in input demand and a reduction in unit cost of production. In fact, the direct effect of reducing interest rate is reducing unit cost of capital by 2.9% leading to an increase in the demand for new capital by 34%. This increases the demand for labor by 9.5% in the short run. Hence, this policy is likely to increase both wages and capital rent by 23.3% and 19%, respectively. Thus, it significantly increases GDP growth rate in both short and long run by 4.7% and 1.6%, respectively.

At the external level, total imports especially from raw materials and capital goods are likely to increase by more than 31% in the short run thanks to more investments. Yet, it is likely to reduce total exports worsening the trade balance in the short run. Over time, this negative effect on trade balance is likely to reverse as it increases total exports by 3.3% and reduces total imports by 0.5% once the economy adjusts to the higher capital accumulation. At the sectoral level, it leads to heterogeneous output effects that depend on the weight of capital input in production cost. Simulation results indicate that twelve out of twenty activities witness a positive increase in aggregate output that ranges between 0.1% in mining activities to 46.1% in vehicle industries, being the most capital intensive. On the other hand, it reduces output in most non-capital intensive sectors especially public administration (15%) and education (8.8%).

Concerning welfare, this policy pushes household and firm disposable incomes up by 24.3% and 26%, respectively. Moreover, following the interest rate cut, consumer price index declines by 3.6 % in the short run leading to an increase private consumption by 3.7% and 1.3% in the short and long run. Given that this policy increases household income simultaneously with consumer price reduction, it leads to the largest welfare gains compared to the other fiscal stimulus package, as shown in Table 3. Yet, the primary beneficiary of this policy response is the richest quantile in

urban area where most capital-intensive activities are located. Table 4 shows the difference in welfare gains according to the geographical region and consumption quantiles and Table 7 summarizes the results of the simulations.

6. Conclusion

Since the official announcement of the COVID-19 pandemic in China in December 2019, the virus has spread rapidly around the world. The virus was declared a global pandemic by the World Health Organization (WHO) in mid-March 2020. To slow the outbreak of this disease, most developed and emerging economies have implemented containment measures with varying levels of severity. Similarly, the Egyptian government applied partial containment measures for a period of 90 days. Using a dynamic recursive CGE, we evaluate the macroeconomic, sector and household effects of the crisis and policy responses.

Our key findings show the extent to which the Egyptian economy has been relatively vulnerable to the global economy as most of its foreign exchange sources have declined. Our analysis also shows how important remittances, private consumption, and informal work are in supporting economic growth in the short term. However, our simulations show that most of the effects of COVID-19 disappear over time. Therefore, while this shock is temporary, further reforms are necessary to make the economy more resilient and less dependent on the global economy. With regard to policy response, we identified five key impacts. First, the increase in current public consumption without sectoral targeting has positive effects on well-being, but undermines long run economic growth and employment. Second, increased government investment without sectoral targeting has a limited impact on short-term growth, well-being and employment. Yet, it increases jobs and long-term well-being with a negative budgetary balance and economic growth. Third, cash transfers to households and business agents increase private consumption but negatively affect economic growth and employment. This is because of its adverse effect on the government's budgetary position as it diminishes the resources that can be allocated to other more productive sectors. Fourth, increased subsidies for production can have similar effects on social welfare as cash transfers, while ensuring economic growth and positive effects on employment. Finally, monetary policy has significant growth and employment effects compared to fiscal policy.

From a policy perspective, our paper has four main implications. First, this article shows how different policy responses have led to different results (because we distinguish between budgetary and monetary policy and between current and productive expenditure). Indeed, productive spending in general is associated with higher externalities, which explains why it has a stronger long run positive impact compared to current spending. Second, targeted stimulus measures for individuals, geographic areas, and sectors are important because of the heterogeneity of different economic agents. Third, most stabilization measures do not have a long-term impact, except monetary policy if it stimulates investment. As a result, further reforms are needed to reduce the vulnerability of the Egyptian economy and make it more resilient to external shocks. Finally, our

simulation analysis highlights the key explanation behind the low impact of the COVID-19 pandemic on Egypt compared to the rest of the MENA region. Indeed, low oil prices, lower interest rates, the rise in public investment in infrastructure, the massive influx of remittances with social protection policies have boosted private consumption and investment. Yet, it is important to note that, while the informal sector was a buffer for the economy, more proactive policies are needed to protect such vulnerable groups.

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Table 2. Macroeconomic Impacts of COVID Pandemic

Simulation	Supply Shock																Demand Shock	
	OIL(PWM +PWX)		OIL(PWM)		TOUR		TRANS		FCUR		REM		LS		INF-LS		CONS	
	Short Run	Lon Run	Short Run	Lon Run	Short Run	Lon Run	Short Run	Lon Run	Short Run	Lon Run	Short Run	Lon Run	Short Run	Lon Run	Short Run	Lon Run	Short Run	Lon Run
Real GDP at market prices	0.45	0.02	0.59	0.04	-0.3	-0.2	-0.91	-0.35	-0.64	-0.53	0.5	2	-5.1	-6.2	1.9	2.7	0.58	0.01
Total consumption	0.33	0.02	0.43	0.04	-0.1	0.1	-0.53	-0.25	0.2	-0.31	0.98	2.37	-4.4	-5.5	3.6	2.7	1.2	-0.2
Consumer Price Index	-0.82	-0.02	-0.25	-0.05	2.72	0.38	0.7	0.22	2.3	0.59	2.51	1.32	7.7	8.3	-3.2	-3.7	0.73	0.21
Total Export	-0.3	0.04	0.07	0.08	14.6	3.5	-0.42	-0.13	-1.92	-0.68	-2.13	-0.65	-7.5	-9.7	3.3	4.6	-0.4	-0.4
Total Imports	1.9	0	2.7	0.01	2.81	0.1	0.38	-0.09	5.06	0.01	3.4	4.37	0.02	-0.86	0.34	-0.31	0.1	-0.04
Total investment expenditure	0.14	0	1.32	0.02	1.7	-0.3	-1.8	-0.64	-0.15	-0.87	6.4	8.9	2.4	1.1	5.23	2.07	-5.6	-0.1
Wages	0.16	-0.02	0.63	-0.02	3.76	0.57	0.61	0.1	4.3	0.65	2.6	2.4	31.5	30.7	-8.1	-8.2	0.47	0.1
Capital rent	-0.21	-0.01	0.52	-0.1	-3.2	0.36	-1.3	0.04	-4.73	0.35	3.3	1.5	5.1	4.7	-0.7	-1.8	0.26	0.32
HH Income	-0.54	-0.01	0.13	-0.02	2.87	0.3	0.14	-0.03	2.2	0.27	3.53	3.74	2.8	2.4	-5.7	-3.9	0.61	0.05
National Welfare	0.52	0.01	0.73	0.01	0.029	0.031	0	0.03	0.02	0.01	0.03	0.11	-3.8	-4.4	0.40	-0.05	0.02	0.01
Firm Income	-0.84	0	-0.04	-0.01	2.15	0.01	-0.38	-0.19	0.71	-0.15	3.1	3.5	3.84	3.49	-0.14	1.67	0.63	0.01
Government Income	0.46	-0.01	1.08	-0.01	0.42	-0.24	-1.08	-0.26	0.38	0.47	3.89	4.64	4.8	3.5	-4.3	-3.7	0.63	0.01

Source: Authors' own elaboration using GAMS.

Table 3. Macroeconomic impacts of the stimulus package

Simulation	Fiscal stimulus package								Monetary stimulus package			
	GOVS1		GOVS2		SOCH+SOCF		SOCP		INF_TR		IR	
	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Real GDP at market prices	0.4	-3.4	0.05	-0.05	-0.2	-2.7	0.9	-0.15	-0.43	-0.56	4.7	1.6
Total consumption	0.6	-2.4	0.02	-0.06	1.5	-0.5	0.74	-0.12	3.0	-0.4	3.7	1.3
Consumer Price Index	3.0	7.9	-0.2	-0.12	0.9	3.8	-0.21	0.15	1.93	0.57	-3.6	-1.0
Total Export	-2.2	-9.4	0.12	0.06	-0.5	-4.9	0.18	-0.25	-1.12	-0.96	-15.2	3.3
Total Imports	0.1	-0.7	-0.01	0.002	-0.1	-0.5	-0.16	-0.02	0.14	-0.10	32.1	-0.5
Total investment expenditure	-10.7	-18.9	-0.1	-0.25	-8.0	-16.5	0.79	-0.1	-4.97	-0.17	25.6	1.4
Wages	6.2	8.7	-0.20	-0.20	0.5	1.8	0.55	0.10	1.22	0.19	23.3	-1.3
Capital rent	2.6	8.3	0.1	0.02	0.2	3.8	0.56	0.23	0.63	0.87	19.00	-3.5
HH Income	3.6	5.3	-0.16	-0.18	2.5	3.3	0.51	0.04	7.0	0.1	24.3	-1.0
National Welfare	0.03	0.05	0.00	0.01	0.02	0.09	0.00	0.01	0.03	-0.02	0.16	0.02
Firm Income	2.3	2.9	-0.12	-0.15	2.7	3.0	0.60	0.01	1.61	0.03	26.0	-0.8
Government Income	2.9	3.3	-0.05	-0.07	2.1	2.3	-6.39	-0.01	-13.0	-0.1	25.0	-0.7

Source: Authors' own elaboration using GAMS.

Table 4. The short run welfare impacts of COVID pandemic and the stimulus package

	Supply Shock								Demand Shock	Fiscal stimulus package					Monetary stimulus package
	OIL (PWM+PWX)	OIL (PWM)	TOUR	TRANS	FCUR	REM	LS	INF-LS	CONS	GOVS1	GOVS2	SOCH+ SOCF	SCOP	TR_INF	IR
HHD-r1	0.57	0.66	0.6	-0.52	0.79	1.33	-6	6.3	0.7	0.39	0	1.1	1.1	8.1	4.7
HHD -r2	0.57	0.72	0.4	-0.8	0.33	1.84	-7.5	5.6	1.1	0.65	0.02	1.6	1.3	8.0	6
HHD -r3	0.56	0.74	0	-1.04	-0.3	2.14	-8.5	6.1	1.5	0.91	0.04	1.9	1.4	8.9	6.9
HHD -r4	0.55	0.75	0	-0.99	-0.28	2.44	-8.6	3.6	2.1	0.99	0.03	2.4	1.4	6.6	7
HHD -r5	0.81	0.99	0	-0.67	0.27	2.91	-9	3.3	2.9	1.2	-0.01	3.3	1.5	6.5	6.9
HHD -u1	0.11	0.16	-0.3	-0.25	0.16	0.25	-2	1.1	0.3	0.12	0.01	0.5	0.3	1.7	1.8
HHD -u2	0.14	0.24	-0.4	-0.55	0.02	0.54	-3.8	2.1	0.8	0.31	0.03	1.1	0.6	3.2	3.4
HHD -u3	0.08	0.27	-0.1	-0.93	-0.57	0.92	-6	3.2	1.3	0.65	0.05	1.9	0.8	5.0	5.2
HHD -u4	0.1	0.41	-0.3	-1.47	-0.87	1.65	-9.3	4.2	2.6	1.13	0.08	3.4	1.3	7.1	8.3
HHD -u5	1.77	2.38	-2.3	-2.91	1.44	4.41	-22.9	6.8	8.2	4.03	0.11	11.7	3.9	14.5	18.9

Source: Authors' own elaboration using GAMS.

Notes: HHD-r1: the poorest household quantile in rural area, HHD -r5: the richest household quantile in rural area, HHD-u1: the poorest household quantile in urban area, HHD -u5: the richest household quantile in urban area

Table 5. The short run impact of COVID pandemic and the stimulus package on aggregate output (by sector)

	Supply Shock								Demand Shock	Fiscal stimulus package					Monetary stimulus package
	OIL(PWM +PWX)	OIL (PWM)	TOUR	TRANS	FCUR	REM	LS	INF-LS	CONS	GOVS1	GOVS2	SOCH +SOCF	SOCP	INF-TR	IR
Agricultural activities	-0.04	-0.08	5.9	3.9	9.1	-0.24	-9.2	7.8	0.29	-0.6	-0.4	0.41	0.26	0.65	-3.5
Mining	-0.06	-0.05	0	0	-0.1	0.01	-1.1	0.0	-0.03	-0.3	0.01	-0.04	-0.01	-0.06	0.1
Agro-processing	0.11	0.17	-3.7	-2	-5.2	0.53	-8.4	5.8	0.84	-0.2	0.2	1.14	0.88	2.46	1
Tobacco and beverage	0.03	0.14	-19.6	-2.4	-21.2	0.78	-10	6.1	1.12	0	0.23	1.52	0.85	3.00	2
Textiles	0.19	0.06	-3.1	-1.4	-4	-0.42	-12.5	5.9	0.48	-1.3	0.18	0.67	0.47	1.37	-5.6
Clothes & Leather	-0.04	0.01	-0.4	-0.5	-0.9	0.32	-7.2	2.9	0.58	-0.2	0.04	0.78	0.28	1.56	0.2
Wood & paper	0.08	0.13	-0.4	-0.5	-0.8	0.45	-8.6	3.6	0.5	-0.7	0.05	0.67	0.23	1.33	1.6
petroleum Products	-1.82	-1.28	-0.2	-0.5	-2.4	0.31	-4.1	2.0	0.27	-0.5	0.03	0.36	0.43	0.71	1.2
Chemicals	0.12	0.05	-0.3	0	-0.2	-0.26	-5	1.9	0.06	-1	0.01	0.1	0.04	0.18	-2.5
Non-Metal	0.63	0.62	-0.4	-0.3	-0.1	0.44	-5.7	2.2	-0.67	-2.2	0.14	-0.95	-0.29	-1.85	5.7
Metal industries	0.7	0.72	-0.8	-0.6	-0.7	0.7	-7.5	3.2	-1.31	-3.9	0.24	-1.84	-0.82	-3.58	10.1
Mechanical industries	0.35	0.23	-1.5	-0.5	-1.5	-0.4	-9.9	4.1	-0.99	-3.7	0.19	-1.35	-0.73	-2.75	-0.4
Vehicles and parts thereof	1.37	1.87	0.2	-1.5	0	3.55	-8.1	2.7	-3.97	-9	0.63	-5.63	-3.13	-11.15	46.1
Other Industries	0.61	0.78	-0.3	-0.7	-0.4	1.51	-6	2.8	-1.78	-4.6	0.31	-2.52	-1.07	-4.83	17.8
Transportation	0.44	0.32	-0.6	-8	-8	-0.31	-7	1.4	0.14	-0.8	0.03	0.2	0.18	0.37	-3.1
Tourism	0.03	-0.06	-22	-0.2	-22	-0.43	-5.7	1.6	0.04	-1.1	0.04	0.08	0.03	0.12	-3.7
Public Administrative	0.07	-0.33	-2.4	-0.1	-2.3	-1.97	-18	1.7	-0.25	10.6	0.1	-0.26	-0.23	-0.45	-15
Education	0.07	-0.16	-1.4	-0.1	-1.3	-1.04	-16.3	0.3	0.07	6.4	0.06	0.14	-0.1	0.39	-8.8
health	0.07	0.07	-0.5	-0.4	-0.7	0.25	-10.7	1.6	0.77	2.5	0.03	1.04	0.36	2.00	-1.2
Other services	-0.08	-0.04	0.5	0.1	0.5	0.13	-5.7	3.1	0.15	-0.8	-0.02	0.2	0.02	0.35	0.3

Source: Authors' own elaboration using GAMS.

Table 6. Households' sources of income

	tr-Firm	tr-gov	tr-Row	L	CAP	total
HHD-r1	40.9	2.8	6.7	34.0	15.7	100.0
HHD-r2	43.2	2.9	7.5	32.1	14.4	100.0
HHD-r3	43.7	3.1	7.5	30.7	15.0	100.0
HHD-r4	44.6	4.4	8.5	29.3	13.3	100.0
HHD-r5	44.5	6.3	9.5	27.6	12.1	100.0
HHD-u1	57.5	3.4	1.7	33.9	3.4	100.0
HHD-u2	60.3	3.8	2.5	31.7	1.7	100.0
HHD-u3	60.0	4.3	3.0	30.6	2.1	100.0
HHD-u4	60.9	5.3	3.7	28.3	1.8	100.0
HHD-u5	62.0	7.4	4.0	25.3	1.4	100.0

Source: Authors' own elaboration using the SAM data.
tr-Firm: transfers from firms (dividend)

Table 7. Simulations Summary

	Growth		Welfare		Trade balance		Fiscal Balance		Employment	
	SR	LR	SR	LR	SR	LR	SR	LR	SR	LR
Oil	↑	↑	↑	↑	↑	↓	↓	↓	↓	↓
REM	↑	↑	↑	↑	↑	↑	↓	↓	↑	↑
TOUR	↓	↓	↑	↑	↓	↓	↑	↑	↓	↓
TRANS	↓	↓	↑	↓	↑	↑	↑	↑	↓	↓
LS	↓	↓	↓	↓	↑	↑	↑	↑	↓	↓
INF-LS	↑	↑	↑	↓	↓	↓	↑	↑	↑	↑
FCUR	↓	↓	↑	↑	↑	↑	↑	↑	↓	↓
CONS	↑	↑	↑	↑	↑	↑	↑	↑	↓	↓
GOVS1	↑	↓	↑	↑	↑	↑	↑	↑	↑	↓
GOVS2	↑	↓	↑	↑	↓	↓	↓	↓	↑	↑
SOCH+ SOCF	↓	↓	↑	↑	↑	↑	↑	↑	↓	↓
SUBP	↑	↓	↑	↑	↓	↑	↑	↑	↑	↑
TR_INF	↓	↓	↑	↓	↑	↑	↑	↑	↑	↑
IR	↑	↑	↑	↑	↑	↓	↓	↓	↑	↓

Source: Authors' own elaboration using GAMS.

Appendix 1: Egypt Macro-SAM (2014/2015), EGP Billion

	Act	com	lab	land	capital	ent	hh	gov	direct tax	import tariffs	sales tax	sub	S/I	change inv	ROW	Total
Activities		4354														4354
Commodities	1997						1857	286					358	16	328	4841
Labor	642															642
Land	38															38
Capital	1678															1678
Enterprises					1516			223							5	1744
Households			642	38	121	1199		119							126	2244
Government						198	11		144	22	99	-152			25	346
Direct Tax						106	38									144
Import Tariffs		22														22
Sales Tax		99														99
Subsidies		-152														-152
Saving/Investment						242	333	-286							86	374
Change In Inventory													16			16
Row		519			41	0	5	5								570
Total	4354	4841	642	38	1678	1744	2244	346	144	22	99	-152	374	16	570	

Source: The *International Food Policy Research Institute* (*IFPRI*), regionalized social accounting matrix (SAM) for Egypt2014/2015

Appendix 2: Major Characteristics of the Egyptian economy

Table A2.1. Macro Indicators of the Egyptian Economy in 2014/2015

	EGP, Billion	Share in GDP %
Private Consumption(C)	1857	80
Investment(I)	374	16
Government Consumption(G)	286	12
Absorption (C+I+G)	2517	108
Export(X)	328	14
Imports(M)	519	22
GDP at Market Prices= C+G+I+(X-M)	2326	100

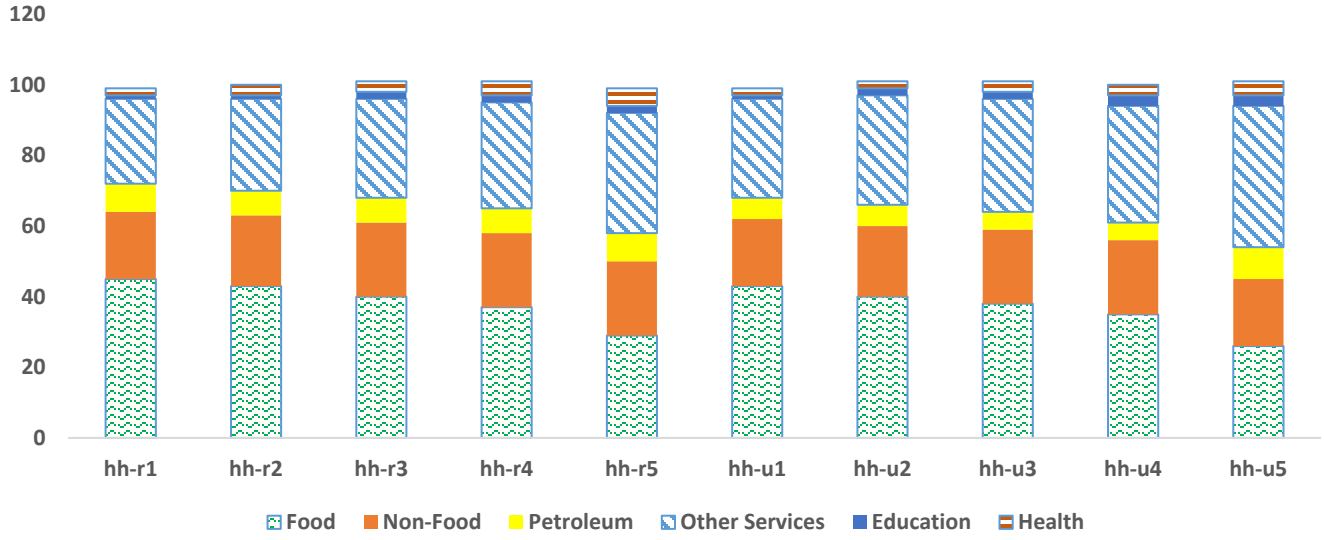
Source: Authors' calculations from 2014/2015 SAM.

Table A2.2. The Structure of Aggregate output and Employment by Activity (%)

	Share of XST	Share of Employment
Other services	22.1%	31.7%
Public Administrative	18.2%	3.9%
Agricultural activities	14.6%	8.4%
Education	14.4%	3.1%
Other Industries	6.9%	12.3%
health	5.7%	2.2%
Transportation	4.9%	4.8%
Agro-processing	2.6%	5.7%
Metal industries	1.7%	4.5%
Tourism	1.4%	2.0%
petroleum Products	1.1%	7.6%
Mining	0.9%	5.5%
Tobacco and beverage	0.9%	1.3%
Chemicals	0.8%	1.6%
Mechanical industries	0.8%	1.2%
Non-Metal	0.8%	1.3%
Wood & paper	0.7%	1.0%
Clothes & Leather	0.6%	0.8%
Textiles	0.6%	0.7%
Vehicles and parts thereof	0.3%	0.4%
Total	**100.0**	**100.0**

Source: Authors' calculations based on 2014/15 SAM

Figure A2.3. Households Consumption Patterns Based on 2014/2015 SAM



Appendix 3: Recursive Dynamic EG_CGE Model Notation

1) Recursive Dynamic EG_CGE Model Notation:

A. List of Sets:

SET	Description
J	All industries
PUB(J)	Public industries
BUS(J)	Private industries
I	All commodities
I1(I)	All commodities except agriculture
L	Labor categories
K	Capital categories
AG	All agents
AGNG(AG)	Non-governmental agents
AGD(AG)	All domestic agents
H(AG)	Households
F(AG)	Firms
T	Time periods

B. Parameters:

Parameters	Description
aij(i,j)	Input output coefficient
α	Tobin q
A^{K_PRI}	Scale parameter (private investment function)
A^{K_PUB}	Scale parameter (public investment function)
B_j^{KD}	Scale parameter (CES - composite capital)
B_j^{LD}	Scale parameter (CES - composite Labor)
B_i^{M}	Scale parameter (CES - composite commodity)
B_j^{VA}	Scale parameter (CES - value added)
$B_{j,i}^{X}$	Scale parameter (CET - exports and local sales)
B_j^{XT}	Scale parameter (CET - total output)
$\beta_{k,j}^{KD}$	Share parameter (CES - composite capital)
$\beta_{l,j}^{LD}$	Share parameter (CES - composite labor)
β_i^{M}	Share parameter (CES - composite commodity)
β_j^{VA}	Share parameter (CES - value added)
$\beta_{j,i}^{X}$	Share parameter (CET - exports and local sales)
$\beta_{j,i}^{XT}$	Share parameter (CET - total output)
$\delta_{k,pub}$ and $\delta_{k,bus}$	Depreciation rate of capital k in industry j
η	Price elasticity of indexed transfers and parameters
frisch(h)	Frisch parameter (LES function)
γ_i^{GVT}	Share of commodity i in total current public expenditures on goods and services
γ_i^{INVPRI}	Share of commodity i in total private investment expenditures
γ_i^{INVPUB}	Share of commodity i in total public investment expenditures

$\gamma_{i,h}^{LES}$	Marginal share of commodity i in household h consumption budget
io(j)	Coefficient (Leontief - intermediate consumption)
$\lambda_{ag,k}^{RK}$	Share of type k capital income received by agent ag
λ_{ag}^{TR}	Share parameter (transfer functions)
$\lambda_{h,l}^{WL}$	Share of type l labor income received by type h households
n(t)	Population growth rate
n1	Population growth rate for the first period
$\emptyset_{k,bus}$	Scale parameter (allocation of investment to industries)
pop(t)	Population index
ρ_j^{KD}	Elasticity parameter (CES - composite capital)
ρ_j^{LD}	Elasticity parameter (CES - composite labor)
ρ_i^M	Elasticity parameter (CES - composite good)
ρ^{VA}	Elasticity parameter (CES - value added)
$\rho_{j,i}^X$	Elasticity parameter (CET - exports and local sales)
ρ_j^{XT}	Elasticity parameter (CET - total output)
$\sigma_{k,bus}^{INV}$	Elasticity (investment demand)
σ_j^{KD}	Elasticity (CES - composite capital)
σ_j^{LD}	Elasticity (CES - composite labor)
σ_i^M	Elasticity (CES - composite good)
σ_j^{VA}	Elasticity (CES - value added)
$\sigma_{j,i}^X$	Elasticity (CET - exports and local sales)
σ_j^{XT}	Elasticity (CET - total output)
σ_i^{XD}	Price elasticity of the world demand for exports of product i
$\sigma_{i,h}^Y$	Income elasticity of consumption
v(j)	Coefficient (Leontief - value added)
Ω	A parameter that measures the response of the sector following the firm production change
Kfr $_{k,j}$	Share of fixed cost in total cost
ε_i^e	Price elasticity of export demand 0<etae<infinity

C. Variables Definition

Variable	Description
Volume variables	
C $_{i,h,t}$	Consumption of commodity i by type h households
CG $_{i,t}$	Public final consumption of commodity i
CI $_{j,t}$	Total intermediate consumption of industry j
CMIN $_{i,h,t}$	Minimum consumption of commodity i by type h households
CTH_REAL $_{h,t}$	Real consumption budget of type h households
DD $_{i,t}$	Domestic demand for commodity i produced locally
DI $_{i,j,t}$	Intermediate consumption of commodity i by industry j
DIT $_{i,t}$	Total intermediate demand for commodity i
DS $_{j,i,t}$	Supply of commodity i by industry j to the domestic market

$EX_{j,i,t}$	Quantity of product i exported by industry j
$EXD_{i,t}$	World demand for exports of product i
G_REAL_{t}	Real current government expenditures on goods and services
$GDP\_BP\_REAL_{t}$	Real GDP at basic prices
$GDP\_MP\_REAL_{t}$	Real GDP at market prices
$GFCF\_PRI\_REAL_{t}$	Real private gross fixed capital formation
$GFCF\_PUB\_REAL_{t}$	Real public gross fixed capital formation
$IM_{i,t}$	Quantity of product i imported
$IND_{k,j,t}$	Investment in capital k for industry j
$INV_{i,t}$	Total final demand of commodity i for investment purposes (GFCF)
$INV\_PRI_{i,t}$	Final demand of commodity i for private investment purposes
$INV\_PUB_{i,t}$	Final demand of commodity i for public investment purposes
$KD_{k,j,t}$	Demand for type k capital by industry j
$KDC_{j,t}$	Industry j demand for composite capital
$KS_{k,t}$	Supply of type k capital
$LD_{l,j,t}$	Demand for type l labor by industry j
$LDC_{j,t}$	Industry j demand for composite labor
$LS_{l,t}$	Supply of type l labor
$Q_{i,t}$	Quantity demanded of composite commodity i
$VA_{j,t}$	Value added of industry j
$VSTK_{i,t}$	Inventory change of commodity i
$XS_{j,i,t}$	Industry j production of commodity i
$XST_{j,t}$	Total aggregate output of industry j

Prices

E_{t}	Exchange rate (price of foreign currency in local currency)
IR_{t}	Interest rate
$P_{j,i,t}$	Basic price of industry j's production of commodity i
$PC_{i,t}$	Purchaser price of composite comodity i (including all taxes and margins)
$PCI_{j,t}$	Intermediate consumption price index of industry j
$PD_{i,t}$	Price of local product i sold on the domestic market (including all taxes and
$PE_{i,t}$	Price received for exported commodity x (excluding export taxes)
$PE\_FOB_{i,t}$	FOB price of exported commodity x (in local currency)
$PIXCON_{t}$	Consumer price index
$PIXGDP_{t}$	GDP deflator
$PIXGVT_{t}$	Public expenditures price index
$PIXINV\_PRI_{t}$	Private investment price index
$PIXINV\_PUB_{t}$	Public investment price index
PK_PRI_{t}	Price of new private capital
PK_PUB_{t}	Price of new public capital
$PL_{i,t}$	Price of local product i (excluding all taxes on products)
$PM_{i,t}$	Price of imported product i (including all taxes and tariffs)
$PP_{j,t}$	Industry j unit cost including taxes directly related to the use of capital and labor but
$PT_{j,t}$	Basic price of industry j's output
$PVA_{j,t}$	Price of industry j value added (including taxes on production directly related to the
$PWM_{i,t}$	World price of imported product i (expressed in foreign currency)

$PWX_{i,t}$	World price of exported product i (expressed in foreign currency)
$R_{k,j,t}$	Rental rate of type k capital in industry j
$RC_{j,t}$	Rental rate of industry j composite capital
$RTI_{k,j,t}$	Rental rate paid by industry j for type k capital including capital taxes
$U_{k,j,t}$	User cost of type k capital in industry j
$W_{l,t}$	Wage rate of type l labor
$WC_{j,t}$	Wage rate of industry j composite labor
$WTI_{l,j,t}$	Wage rate paid by industry j for type l labor including payroll taxes

Nominal (value) variables

CAB_{t}	Current account balance
$CTH_{h,t}$	Consumption budget of type h households
G_{t}	Current government expenditures on goods and services
GDP_BP_{t}	GDP at basic prices
GDP_FD_{t}	GDP at purchasers' prices from the perspective of final demand
GDP_IB_{t}	GDP at market prices (income-based)
GDP_MP_{t}	GDP at market prices
$GFCF_{t}$	Gross fixed capital formation
IT_{t}	Total investment expenditures
IT_PRI_{t}	Total private investment expenditures
IT_PUB_{t}	Total public investment expenditures
$SF_{f,t}$	Savings of type f businesses
SG_{t}	Government savings
$SH_{h,t}$	Savings of type h households
$SROW_{t}$	Rest-of-the-world savings
$TDF_{f,t}$	Income taxes of type f businesses
$TDFT_{t}$	Total government revenue from business income taxes
$TDH_{h,t}$	Income taxes of type h households
$TDHT_{t}$	Total government revenue from household income taxes
$TIC_{i,t}$	Government revenue from indirect taxes on product i
$TICT_{t}$	Total government receipts of indirect taxes on commodities
$TIS_{i,t}$	Government sub exp on product i
$TIST_{t}$	Total government sub exp on commodities
$TIK_{k,j,t}$	Government revenue from taxes on type k capital used by industry j
$TIKT_{t}$	Total government revenue from taxes on capital
$TIM_{i,t}$	Government revenue from import duties on product i
$TIMT_{t}$	Total government revenue from import duties
$TIP_{j,t}$	Government revenue from taxes on industry j production (excluding taxes directly
$TIPT_{t}$	Total government revenue from production taxes (excluding taxes directly related to
$TIW_{l,j,t}$	Government revenue from payroll taxes on type l labor in industry j
$TIWT_{t}$	Total government revenue from payroll taxes
$TIX_{i,t}$	Government revenue from export taxes on product i
$TIXT_{t}$	Total government revenue from export taxes
$TPRCTS_{t}$	Total government revenue from taxes on products and imports
$TPRODN_{t}$	Total government revenue from other taxes on production
$TR_{ag,agj,t}$	Transfers from agent agj to agent ag

$YDF_{f,t}$	Disposable income of type f businesses
$YDH_{h,t}$	Disposable income of type h households
$YF_{f,t}$	Total income of type f businesses
$YFK_{f,t}$	Capital income of type f businesses
$YFTR_{f,t}$	Transfer income of type f businesses
YG_{t}	Total government income
YGK_{t}	Government capital income
$YGTR_{t}$	Government transfer income
$YH_{h,t}$	Total income of type h households
$YHK_{h,t}$	Capital income of type h households
$YHL_{h,t}$	Labor income of type h households
$YHTR_{h,t}$	Transfer income of type h households
$YROW_{t}$	Rest-of-the-world income

Rates and intercepts

$sh0_{h,t}$	Intercept (type h household savings)
$sh1_{h,t}$	Slope (type h household savings)
$tr0_{h,t}$	Intercept (transfers by type h households to government)
$tr1_{h,t}$	Marginal rate of transfers by type h households to government
$ttdf0_{f,t}$	Intercept (income taxes of type f businesses)
$ttdf1_{f,t}$	Marginal income tax rate of type f businesses
$ttdh0_{h,t}$	Intercept (income taxes of type h households)
$ttdh1_{h,t}$	Marginal income tax rate of type h households
$ttic_{i,t}$	Tax rate on commodity i
$ttis_{i,t}$	Subsidy rate on commodity i
$ttik_{k,j,t}$	Tax rate on type k capital used in industry j
$ttim_{i,t}$	Rate of taxes and duties on imports of commodity m
$ttip_{j,t}$	Tax rate on the production of industry j
$ttiw_{l,j,t}$	Tax rate on type l worker compensation in industry j
$ttix_{i,t}$	Export tax rate on exported commodity x

Other Variables

$EV_{h,t}$	Equivalent variation for households
EVT_{t}	National welfare
$LEON_{t}$	Excess supply on the last market

D. List of equations:

Production

$VA_{j,t} = v_j \; XST_{j,t}$ (1)

$CI_{j,t} = io_j \; XST_{j,t}$ (2)

$$VA_{j,t} = B_j^{VA} \left(\beta_j^{VA} \, LDC_{j,t}^{-\rho^{VA}} + \left(1-\beta_j^{VA}\right) KDC_{j,t}^{-\rho^{VA}}\right)^{-\frac{1}{\rho_j^{VA}}} \quad (3)$$

$$LDC_{j,t} = \left[\frac{\beta_j^{VA}}{1-\beta_j^{VA}} \; \frac{RC_{j,t}}{WC_{j,t}}\right]^{\sigma_j^{VA}} KDC_{j,t} \quad (4)$$

$$LDC_{j,t} = B_j^{LD} \left[\sum_l \beta_{l,j}^{LD} \; LD_{l,j,t}^{-\rho_j^{LD}}\right]^{-\frac{1}{\rho_j^{LD}}} \quad (5)$$

$$LD_{l,j,t} = \left[\frac{\beta_{l,j}^{LD} \, WC_{j,t}}{WTI_{l,j,t}}\right]^{\sigma_j^{LD}} \left(B_j^{LD}\right)^{\sigma_j^{LD}-1} LDC_{j,t} \quad (6)$$

$$KDC_{j,t} = B_j^{KD} \left[\sum_k \beta_{k,j}^{KD} \; KD_{k,j,t}^{-\rho_j^{KD}}\right]^{-\frac{1}{\rho_j^{KD}}} \quad (7)$$

$$KD_{k,j,t} = \left[\frac{\beta_{k,j}^{KD} \, RC_{j,t}}{RTI_{k,j,t}}\right]^{\sigma_j^{KD}} \left(B_j^{KD}\right)^{\sigma_j^{KD}-1} KDC_{j,t} \quad (8)$$

$DI_{i,j,t} = aij_{i,j} \; CI_{j,t}$ (9)

Incomes and Savings

$YH_{h,t} = YHL_{h,t} + YHK_{h,t} + YHTR_{h,t}$ (10)

$$YHL_{h,t} = \sum_l \lambda_{h,l}^{WL} \left[W_{l,t} \; \sum_j LD_{l,j,t}\right] \quad (11)$$

$$YHK_{h,t} = \sum_k \lambda_{h,k}^{RK} \left[\sum_j R_{k,j,t} KD_{k,j,t}\right] \quad (12)$$

$$YHTR_{h,t} = \sum_{ag} TR_{h,ag,t} \quad (13)$$

$YDH_{h,t} = YH_{h,t} - TDH_{h,t} - TR_{gvt,h,t}$ (14)

$$CTH_{h,t} = YDH_{h,t} - SH_{h,t} - \sum_{agng} TR_{agng,h,t} \quad (15)$$

$$SH_{h,t} = PIXCON_t^{\eta} \; sh0_{h,t} + sh1_{h,t} \; YDH_{h,t} \quad (16)$$

$$TR_{agng,h,t} = \lambda_{agng,h}^{TR} \; YDH_{h,t} \quad (17)$$

$$TR_{gvt,h,t} = PIXCON_t^{\eta} \; tr0_{h,t} + tr1_{h,t} \; YH_{h,t} \quad (18)$$

$YF_{f,t} = YFK_{f,t} + YFTR_{f,t}$ (19)

$$YFK_{f,t} = \sum_k \lambda_{f,k}^{RK} \left[\sum_j R_{k,j,t} KD_{k,j,t}\right] \quad (20)$$

$$YFTR_{f,t} = \sum_{ag} TR_{f,ag,t} \quad (21)$$

$YDF_{f,t} = YF_{f,t} - TDF_{f,t}$ (22)

$$SF_{f,t} = YDF_{f,t} - \sum_{ag} TR_{ag,f,t} \quad (23)$$

$$TR_{agng,f,t} = \lambda_{ag,f}^{TR} \; YDF_{f,t} \quad (24)$$

$YG_t = YGK_t + TDHT_t + TDFT_t + TPRODN_t + TPRCTS_t + YGTR_t$ (25)

$TPRODN_t = TIWT_t + TIKT_t + TIPT_t$ (26)

$TPRCTS_t = TICT_t + TIST_t + TIMT_t + TIXT_t$ (27)

$$YGK_{f,t} = \sum_k \lambda_{gvt,k}^{RK} \left[\sum_j R_{k,j,t} KD_{k,j,t}\right] \quad (28)$$

$$YGTR_t = \sum_{agng} TR_{gvt,agng,t} \quad (29)$$

$$TDHT_t = \sum_h TDH_{h,t} \quad (30)$$

$$TDH_{h,t} = PIXCON_t^{\eta} \; ttdh0_{h,t} + ttdh1_{h,t} \; YH_{h,t} \quad (31)$$

$$TDFT_t = \sum_f TDF_{f,t} \quad (32)$$

$$TDF_{f,t} = PIXCON_t^{\eta}\ ttdf0_{f,t} + ttdf1_{f,t}\ YFK_{f,t} \quad (33)$$

$$TIW_{l,j,t} = ttiw_{l,j,t}\ W_{l,t}\ LD_{l,j,t} \quad (34)$$

$$TIWT_t = \sum_{l,j} TIW_{l,j,t} \quad (35)$$

$$TIK_{k,j,t} = ttik_{,k,j,t}\ R_{k,j,t}\ KDk_{,,j,t} \quad (36)$$

$$TIKT_t = \sum_{k,j} TIK_{k,j,t} \quad (37)$$

$$TIP_{j,t} = ttip_{j,t}\ PP_{j,t}\ XST_{j,t} \quad (38)$$

$$TIPT_t = \sum_j TIP_{j,t} \quad (39)$$

$$TIC_{i,t} = ttic_{i,t}\{PL_{i,t}\ DD_{i,t} + (1 + ttim_{i,t})PWM_{i,t}\ e_t\ IM_{i,t}\} \quad (40)$$

$$TICT_t = \sum_i TIC_{i,t} \quad (41)$$

$$TIS_{i,t} = ttis_{i,t}\{PL_{i,t}\ DD_{i,t} + (1 + ttim_{i,t})PWM_{i,t}\ e_t\ IM_{i,t}\} \quad (42)$$

$$TIST_t = \sum_i TIS_{i,t} \quad (43)$$

$$TIMT_t = \sum_i TIM_{i,t} \quad (44)$$

$$TIM_{i,t} = ttim_{i,t}\ PWM_{i,t}\ e_t\ IM_{i,t} \quad (45)$$

$$TIXT_t = \sum_i TIX_{i,t} \quad (46)$$

$$TIX_{i,t} = ttix_{i,t}\ PE_{i,t}\ EXD_{i,t} \quad (47)$$

$$TR_{agng,gvt,t} = PIXCON_t^{\eta}\ TR^o_{agng,gvt}\ POP_t \quad (48)$$

$$SG_t = YG_t - \sum_{agng} TR_{agng,gvt,t} - G_t \quad (49)$$

$$YROW_t = e_t\ \sum_i PWM_{i,t}\ IM_{i,t} + \sum_k \lambda^{RK}_{row,k}\ \left(\sum_j R_{k,j,t}\ KD_{k,j,t}\right) + \sum_{agd} TR_{row,agd,t} \quad (50)$$

$$TR_{agd,row,t} = PIXCON_t^{\eta}\ TR^o_{agd,row}\ POP_t \quad (51)$$

$$SROW_t = YROW_t - \sum_i PE^{FOB}_{i,t}\ EXD_{i,t} - \sum_{agd} TR_{agd,row,t} \quad (52)$$

$$SROW_t = -CAB_t \quad (53)$$

Demand

$$PC_{i,t}\ C_{i,t} = PC_{i,t}\ C^{MIN}_{i,h,t} + \gamma^{LES}_{i,h}\{CTH_{h,t} - \sum_{ij} PC_{ij,t}\ C^{MIN}_{ij,h,t}\} \quad (54)$$

$$PC_{i,t}\ CG_{i,t} = \gamma_i^{GVT}\ G_t \quad (55)$$

$$GFCF_t = IT_t - \sum_i PC_{i,t}\ VSTK_{i,t} \quad (56)$$

$$PC_{i,t}\ INV^{PRI}_{i,t} = \gamma_i^{INVPRI}\ IT_t^{PRI} \quad (57)$$

$$PC_{i,t}\ INV^{PUB}_{i,t} = \gamma_i^{INVPUB}\ IT_t^{PUB} \quad (57)$$

$$INV_{i,t} = INV^{PRI}_{i,t} + INV^{PUB}_{i,t} \quad (58)$$

$$DIT_{i,t} = \sum_j DI_{i,j,t} \quad (59)$$

Supply and International Trade

$$XST_{j,t} = B_j^{XT}\left[\sum_k \beta^{XT}_{j,i}\ XS^{\rho_j^{XT}}_{j,i,t}\right]^{\frac{1}{\rho_j^{XT}}} \quad (60)$$

$$XS_{j,i,t} = \frac{XST_{j,t}}{\left(B_j^{XT}\right)^{1+\sigma_j^{XT}}}\left[\frac{P_{j,i,t}}{\beta^{XT}_{j,i}\ PT_{j,t}}\right] \quad (61)$$

$$XS_{j,i,t} = B^X_{j,i}\left[\beta^X_{j,i}\ EX^{\rho^X_{j,i}}_{j,i,t} + \left(1 - \beta^X_{j,i}\right)DS^{\rho^X_{j,i}}_{j,i,t}\right]^{\frac{1}{\rho^X_{j,i}}} \quad (62)$$

$$EX_{j,i,t} = \left[\frac{\left(1-\beta^X_{j,i}\right)}{\beta^X_{j,i}}\ \frac{PE_{i,t}}{PL_{i,t}}\right]^{\sigma^X_{j,i}} DS_{j,i,t} \quad (63)$$

$$EXD_{i,t} = EXD^0_{i,t}\ POP_t\ \left(\frac{e_t PWX_{i,t}}{PE^{FOB}_{i,t}}\right)^{\sigma_i^{XD}} \quad (64)$$

$$Q_{i,t} = B_i^M\left[\beta_i^M\ IM_{i,t}^{-\rho_i^M} + \left(1 - \beta_i^M\right)DD_{i,t}^{-\rho_i^M}\right]^{\frac{-1}{\rho_i^M}} \quad (65)$$

$$IM_{i,t} = \left[\frac{(1-\beta_i^M)}{\beta_i^M}\frac{PD_{i,t}}{PM_{i,t}}\right]^{\sigma_i^M} DD_{i,t} \quad (66)$$

Prices

$$PP_{j,t} = \frac{PV_{j,t}\,VA_{j,t} + PCI_{j,t}\,CI_{j,t}}{XST_{j,t}} \quad (67)$$

$$PT_{j,t} = \left(1 + ttip_{j,t}\right) PP_{j,t} \quad (68)$$

$$PCI_{j,t} = \frac{\sum_i PC_{i,t}\,DI_{i,j,t}}{CI_{j,t}} \quad (69)$$

$$PVA_{j,t} = \frac{WC_{j,t}\,LDC_{j,t} + RC_{j,t}\,KDC_{j,t}}{VA_{j,t}} \quad (70)$$

$$WC_{j,t} = \frac{\sum_l WTI_{l,j,t}\,LD_{l,j,t}}{LDC_{j,t}} \quad (71)$$

$$WTI_{l,j,t} = \left(1 + ttiw_{l,j,t}\right) W_{l,j,t} \quad (72)$$

$$RC_{j,t} = \frac{\sum_k RTI_{k,j,t}\;KD_{k,j,t}}{KDC_{j,t}} \quad (73)$$

$$RTI_{k,j,t} = \left(1 + ttik_{k,j,t}\right) R_{k,j,t} \quad (74)$$

$$PT_{j,t} = \frac{\sum_i P_{j,i,t}\;XS_{j,i,t}}{XST_{j,t}} \quad (75)$$

$$P_{j,i,t} = \frac{PE_{i,t}\;EX_{j,i,t} + PL_{i,t}\;DS_{j,i,t}}{XS_{j,i,t}} \quad (76)$$

$$PE_{i,t}^{FOB} = PE_{i,t}\left(1 + ttix_{i,t}\right) \quad (77)$$

$$PD_{i,t} = \left(1 + ttic_{i,t} + ttis_{i,t}\right) PL_{i,t} \quad (78)$$

$$PM_{i,t} = \left(1 + ttic_{i,t} + ttis_{i,t}\right)\left(1 + ttim_{i,t}\right) e_t\, PWM_{i,t} \quad (79)$$

$$PC_{i,t} = \frac{PM_{i,t}\;IM_{i,t} + PD_{i,t}\;DD_{i,t}}{Q_{i,t}} \quad (80)$$

GDP Deflator

$$PIXGDP_t = \sqrt{\frac{\sum_j PVA_{j,t}\,VA^0{}_j\;\sum_j PVA_{j,t}\,VA_{j,t}}{\sum_j PVA^0{}_j\,VA^0{}_j\;\sum_j PVA^0{}_j\,VA_{j,t}}} \quad (81)$$

Consumer Price index

$$PIXCON_t = \frac{\sum_i PC_{i,t}\;\sum_h C^0{}_{i,h}}{\sum_{ij} PC^0{}_{ij,t}\;\sum_h C^0{}_{ij,h}} \quad (82)$$

Investment Price Index

$$PIXINV_t^{PRI} = \prod_i \left(\frac{PC_{i,t}}{PC_i^0}\right)^{\gamma_i^{INVPRI}} \quad (83)$$

$$PIXINV_t^{PUB} = \prod_i \left(\frac{PC_{i,t}}{PC_i^0}\right)^{\gamma_i^{INVPUB}} \quad (84)$$

Public Expenditure Price Index

$$PIXGVT_t = \prod_i \left(\frac{PC_{i,t}}{PC_i^0}\right)^{\gamma_i^{GVT}} \quad (85)$$

Equilibrium

$$Q_{i,t} = \sum_h C_{i,h,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t} + DIT_{i,t} \quad (86)$$

$$\sum_j LD_{l,j,t} = LS_{l,t} \quad (87)$$

$$\sum_j KD_{k,j,t} = KS_{k,t} \quad (87)$$

$$IT_t = \sum_h SH_{h,t} + \sum_f SF_{f,t} + SG_t + SROW_t \quad (88)$$

$$\sum_j DS_{j,i,t} = DD_{i,t} \quad (89)$$

$$\sum_j EX_{j,i,t} = EXD_{i,t} \quad (90)$$

Gross Domestic Product

$$GDP_t^{BP} = \sum_j PVA_{j,t}\ VA_{j,t} + TIPT_t \quad (91)$$

$$GDP_t^{MP} = GDP_t^{BP} + TPRCTS_t \quad (92)$$

$$GDP_t^{IB} = \sum_{l,j} W_{l,t}\ LD_{l,j,t} + \sum_{k,j} R_{k,t}\ KD_{k,j,t} + TPRODN_t + TPRCTS_t \quad (93)$$

$$GDP_t^{FD} = \sum_i PC_{i,t}\ \left[\sum_h C_{i,h,t} + CG_{i,t} + INV_{i,t} + VSTK_{i,t}\right] + \sum_i PE_{i,t}^{FOB}\ EXD_{i,t} - \sum_i e_t\ PWM_{i,t}\ IM_{i,t} \quad (94)$$

Dynamic Equations

$$IT_t^{PUB} = PK_t^{PUB}\ \sum_{k,pub} IND_{k,pub,t} \quad (95)$$

$$PK_t^{PUB} = \frac{1}{A^{K\_PUB}} \prod_i \left(\frac{PC_{i,t}}{\gamma_i^{INVPUB}}\right)^{\gamma_i^{INVPUB}} \quad (96)$$

$$KD_{k,pub,t+1} = KD_{k,pub,t}\left(1 - \delta_{k,pub}\right) + IND_{k,pub,t} \quad (97)$$

$$IT_t^{PRI} = IT_t - IT_t^{PUB} - \sum_i PC_{i,t} VSTK_{i,t} \quad (98)$$

$$IT_t^{PRI} = PK_t^{PRI}\ \sum_{k,bus} IND_{k,bus,t} \quad (99)$$

$$PK_t^{PRI} = \frac{1}{A^{K\_PRI}} \prod_i \left(\frac{PC_{i,t}}{\gamma_i^{INVPRI}}\right)^{\gamma_i^{INVPRI}} \quad (100)$$

$$IND_{k,bus,t} = \emptyset_{k,bus} \left[\frac{R_{k,bus,t}}{U_{k,bus,t}}\right]^{\sigma_{k,bus}^{INV}} KD_{k,bus,t} \quad (101)$$

$$KD_{k,bus,t+1} = KD_{k,bus,t}\left(1 - \delta_{k,bus}\right) + IND_{k,bus,t} \quad (102)$$

$$U_{k,bus,t} = PK_t^{PRI}\left(\delta_{k,bus} + IR_t\right) \quad (103)$$

$$EV_{h,t} = \left\{\left(CTH_{h,t} - \sum_{ij} PC_i\ CMIN_{ij,t}\right) \prod_i \left[\frac{PC_i^0}{PC_{i,t}}\right]^{\gamma^{LES}{}_{i,h}} - \left({CTH_{h,t}}^0 - \sum_{ij} {PC^0}_i\ {CMIN^0}_{ij,t}\right)\right\} \quad (104)$$

$$EVT_t = \frac{\sum_h CTH_{h,t}\ PIXCON^0 - \sum_h {CTH^0}_h\ PIXCON^0}{\sum_h YH_{h,t}} \quad (105)$$