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Phasing Out Energy Subsidies as Part of Egypt's Economic Reform Program

Impacts and Policy Implications

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ACRONYMS

CAPMAS	Central Agency for Public Mobilization and Statistics
CBE	Central Bank of Egypt
DCGE	Dynamic Computable General Equilibrium Model
EGP	Egyptian Pound
GDP	gross domestic product
GOE	Government of Egypt
GST	General Sales Tax
IMF	International Monetary Fund
LPG	Liquefied Petroleum Gas
MoF	Ministry of Finance
MPMAR	Ministry of Planning, Monitoring and Administrative Reform
SAM	Social Accounting Matrix
VAT	Value-added Tax

ABSTRACT

In order to address long-standing economic challenges, in 2016 the Government of Egypt (GOE) put in place a major economic reform program to restore macroeconomic stability and to promote inclusive growth. As a result, there are early signs that the economy is rebounding and Egypt's economic outlook is becoming more favorable. However, it is less clear how the ongoing reform program is affecting households, especially the poor. To shed light on this question, this paper uses an economy-wide dynamic computable general equilibrium (DCGE) model to estimate the distributional impacts of the energy subsidy cuts in 2014, 2016, and 2017; the currency devaluation at the end of 2016; and the expected complete phasing out of energy subsidies over the coming years. As such, the paper compares the outcomes of a business as usual scenario (no policy change) with alternative policy scenarios without necessarily replicating the exact growth path of the Egyptian economy.

The results of this modeling exercise suggest that the reform program reduces economic growth by a modest 2.5 to 2.6 percent in the short-run, but accelerates economic growth in the longer run by 0.6 to 1.8 percent, even if energy subsidies continue to be phased out. In the short-term, only mining and construction are likely to benefit from the reform program, whereas in the longer-term other sectors, such as agriculture, agro-processing, and non-transport services, stand to gain. The results also show that the reform program resulted in household consumption levels declining between 3.8 and 4.6 percent overall, but that the increase in food subsidies and the introduction of the cash transfer program, Takaful and Karama, helped to mitigate adverse impacts on the consumption of the poor.

These findings complement other findings from the Poverty and Social Impact Analysis (World Bank 2017, section 5.1) in several important ways. Methodologically, this paper goes beyond the *partial and static* equilibrium perspective and provides a *general dynamic* equilibrium perspective. This dynamic perspective is usually considered to be more comprehensive as it takes into account both the *indirect* impacts of policy changes and the capacity enhancing impacts of investment *over time*. Specifically, the DCGE analysis presented in this paper provides a comparison between short-run contraction and long-run expansion effects that result from a reallocation of factors from energy-intensive and import-intensive sectors towards energy-extensive and export-oriented or import-substituting sectors. In addition, the DCGE analysis considers the potential investment and growth enhancing effects of fiscal savings that may come with the phasing out of energy subsidies. Accounting for these additional dimensions is important as they affect the expenditure patterns *and* the income earnings possibilities of different household types, both in the short and the longer run.

Consistent with the experience and findings from other countries, the results of this paper suggest that the energy subsidy reform in Egypt is likely to have positive socio-economic impacts in the medium to longer run. Despite possible negative impacts in the short-run, it is therefore important to sustain the reform momentum. Yet, there are several measures that would likely accelerate the positive impacts of the reforms, including a more business friendly environment, measures that increase labor market flexibility, and restraint in raising public and private sector wages to reap the benefits of real depreciation. Finally, targeted social protection measures should be continued and scaled up.

1. INTRODUCTION

By the end of the 2015/16 fiscal year, a long-standing mix of high government deficits, an overvalued exchange rate, a growing current account deficit, and declining gross international reserves had resulted in low economic growth and severe shortages of foreign exchange in Egypt (IMF 2018).[1] The fiscal deficit had reached around 12.5 percent of GDP in 2015/16 as a result of increasing government spending on subsidies and interest payments combined with lower revenues. The current account deficit reached around 6 percent of GDP in 2015/16 as tourism revenues, foreign direct investment, and remittances had all declined over the past years (CBE 2018). GDP growth rate had dropped to 2.2 percent in 2012/13. And while GDP growth had recovered to 4.3 percent in 2015/16, this growth rate was still below average growth rate of 5.5 percent that prevailed during the period 2004 to 2010 and was insufficient to reduce poverty and unemployment (MPMAR, various years).

Facing these severe economic challenges, the Government of Egypt (GOE) put in place a comprehensive economic reform program to restore macroeconomic stability and promote inclusive growth.[2] The reform program includes the flotation of the exchange rate[3], the phasing out of energy subsidies, and the introduction of a value-added tax (VAT) as its main elements. With the aim of improving the business climate and boosting investors' confidence, the GOE has also formulated a new investment law to ease the establishment of new companies and encourage more investment. In the same context, the Central Bank of Egypt has eased restrictions on foreign currency transfers to facilitate the repatriation of profits for foreign companies operating in Egypt (EIU 2017). To protect the poor and vulnerable from the anticipated (negative) impacts of such a comprehensive reform program, the GOE also expanded its social safety net by reforming and scaling up food subsidies and introducing a cash transfer program.[4] The GOE has moved food subsidies from a ration card to a voucher-based system and increased the food subsidy allocations in 2017/18, increasing the monthly allowance per card from EGP 15 to EGP 21 for about 71 million beneficiaries (MoF 2017). In March 2015, the GOE also introduced a cash transfer program, Takaful and Karama, to provide income support to poor families with children, to the elderly poor, and to people with disabilities (MoF 2017).

While there are signs that the economy is rebounding and Egypt's economic outlook is becoming more favorable (IMF 2018), it is less clear how the reform program has affected households, especially the poor. The objective of this paper is to estimate the impact of the economic reform program on households based on simulations using pre-reform data, with a specific emphasis on the energy subsidy reform. We focus on the energy subsidy reform for several reasons.

1. The energy subsidy reform is an ongoing process that is planned to continue until at least 2020, when domestic energy prices should reach world market levels.[5] As such, the findings

[1] The fiscal year of the government of Egypt begins 1 July.

[2] The program is supported by the IMF, which in November 2016 approved a 3-year extended fund facility for Egypt (EFF) of USD 12 billion.

[3] The CBE announced the floatation of the Egyptian pound in November 2016. The Egyptian pound fell sharply from 1.0 USD = 8.8 EGP prior to the flotation to 17.7 EGP in early-2018. (http://www.cbe.org.eg/ar/EconomicResearch/Statistics/Pages/ExchangeRateshistorical.aspx).

[4] Experience from other countries showed that protecting the poor during economic reform processes is critical for success. Mexico in the 1990s, for example, followed a similar approach to that of Egypt (https://vimeo.com/208634558).

[5] According to the IMF (2018), the government plans to achieve 100 percent cost recovery by the end of the 2018/19 fiscal year for all fuel items, excluding LPG.

from the simulations done in this paper are not only useful for estimating the distributional impacts of the reform steps taken between 2014 and 2017, but may also help decision making regarding the size of the expected impacts that are still to come.

2. The devaluation was a one-time shock to the economy, rather than an ongoing policy reform process. As such, while we capture the devaluation as part of our scenarios, we put less emphasis on this issue in our discussion of results.
3. We do not specifically examine the impact of value-added taxes, as the shift from the pre-existing sales tax to a value-added tax is more a shift in tax systems rather than a new tax. It is not expected to have large distributions implications. In addition, the absence of detailed data on the new and old tax rates by specific product and their matching to data in the social accounting matrix (SAM) would make it extremely difficult to assess such a shift in an economy-wide framework.[6]
4. Finally, we include the impact of scaling up of the food subsidies and the introduction of the cash transfer program in our analysis to estimate how those programs may have helped households to mitigate the impacts of the energy subsidy reforms, especially the poor.

The remainder of this paper is structured as follows. Section two first presents the global literature on the impacts of energy subsidy reforms and currency devaluations. In its second part, it provides the country-specific background for Egypt. Section three presents the economy-wide model for Egypt and scenarios run in the model reflecting the recent economic reforms. Section four discusses the results, and section five concludes.

2. ENERGY SUBSIDIES IN EGYPT IN THE CONTEXT OF CURRENCY DEVALUATION

Global experience

In the absence of more sophisticated social welfare systems, energy subsidies are still in place in several mainly low and middle-income countries. These subsidies have the objectives of redistributing wealth among citizens and shielding domestic consumers from increases in international energy prices and excessive volatility in those prices (IMF 2017). However, energy subsidies represent a fiscal burden on the government budget, often contribute to large fiscal deficits, and drain resources from more growth-promoting and poverty-reducing spending, such as on infrastructure, education, and health. The existence of subsidies and related incentives for overconsumption of energy can also contribute to a deterioration in the balance of payments, owing to higher energy imports (for energy-importing countries). High levels of subsidy also often lead to distortions in the economy, as energy subsidies usually create a bias in favor of capital-intensive and energy-intensive industries, such as petrochemicals, steel, cement, fertilizers, aluminum, and

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[6] The VAT law was enacted in September 2016 to replace the general sales tax (GST) that was in place since 1991. The tax base is widened under the new VAT system, as it includes more products and services that were previously exempted under the GST. The tax rate was not unified under the GST – each group of products had its own tax rate, but on average it was around 10 percent (Lotfi 2016). GST was imposed on both domestic and imported goods, but was applied to only 17 services. GST was added on the final price of goods and services and was paid by the final consumers, whereas the VAT is a unified tax rate for all items, hence reducing the distortionary effects of the previous GST system. Starting from July 2017, VAT has increased from 13 percent to 14 percent for FY 2017/18 (MoF 2017). However, there are still many exempted sectors under the new VAT, including basic food and agriculture products, financial services and the banking sector, health and education services, and transportation (except transportation for internal and foreign tourism) (VAT law no.67 for 2016). Previous studies showed that applying the VAT system leads to an increase in the CPI only once during the first year of implementation – FY2017 in the case of Egypt. VAT is also expected to lead to an increase in government revenues by one percent of GDP in FY2017 (World Bank 2016).

copper,) diverting resources towards these sectors at the expense of more labor-intensive and, thus, job-creating industries (IMF 2015). Energy subsidies often hinder economic diversification and reduce incentives towards the adoption of more innovative technologies, especially energy-efficient technologies. In addition, subsidized energy prices often tend to benefit better-off households, owing to their higher energy consumption, e.g., through car ownership and the use of air conditioners (IMF 2017). For example, the IMF estimates that the poorest quintile in Egypt, Jordan, Mauritania, Morocco, and Yemen receive only between 1 and 7 percent of total diesel subsidies, while the richest quintile received 42 to 77 percent of the total value of these subsidies (El-Katiri and Fattouh 2015).

In light of these serious disadvantages of energy subsidies, the number of countries engaging in energy subsidy reforms has increased in recent years, including in Middle East and North Africa (MENA) in countries, such as Egypt, Jordan, and Sudan. However, research and empirical evidence shows that phasing out energy subsidies can lead to a short-term decline in GDP during the adjustment process as enterprises face higher costs of energy inputs (Verne 2016). Moreover, the increase in energy prices negatively affect real household incomes directly through higher energy prices and indirectly through higher prices of other goods and services that come with the higher costs for intermediate inputs, such as transportation, trade, and others. Coady et al. (2015) estimate that an increase of $0.25 per liter in fuel prices may results in a 5.5 percent decline in real household incomes, on average, across 32 countries. The impact ranges from 3.5 percent in South and Central America to 7.0 percent in MENA, where retail prices are still comparatively low. In Egypt, several studies estimated the potential impact of energy subsidy reform. Griffin, Laursen, and Robertson (2016) and Banerjee et al. (2017) used dynamic computable general equilibrium (DCGE) models and found that the impact of the energy subsidy cut in July 2014 should lead to only a modest decline in real household consumption and only a slight increase in poverty in the short-term, while resulting in sizeable structural change in the economy and increase in economic growth in the longer term. Since these two studies for Egypt were conducted, the GOE has scaled up its economic reform agenda significantly by floating the exchange rate and by further cutting energy subsidies.

Based on the international literature, several factors are likely to be important for the successful implementation of energy subsidies.

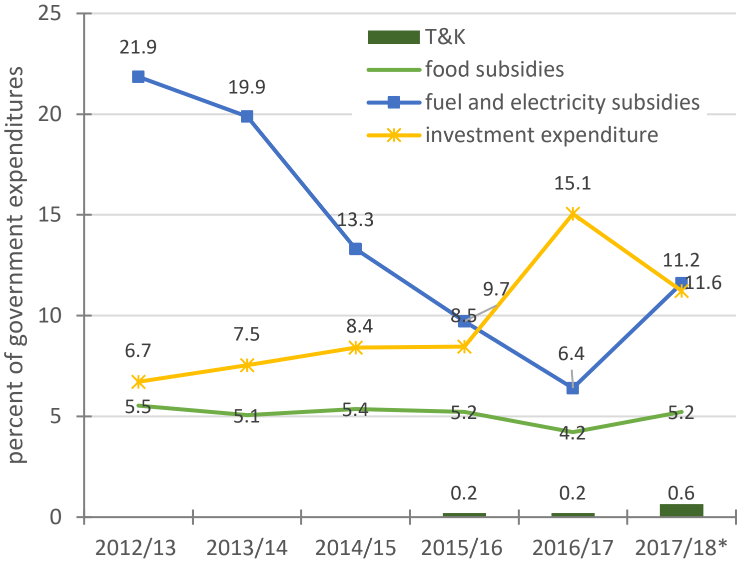
- Communicating to citizens the rationale for energy subsidy reform can help obtain buy in and support for the reform (Coady et al. 2015).
- Rather than phasing out energy subsidies at once, a gradual approach spanning several years can be preferable to give enterprises and households time to adjust (Breisinger et al. 2012; Coady et al. 2015).
- Successful implementation of energy subsidy reform also depends on a credible compensation mechanism, such as a comprehensive social safety net, to mitigate the negative impacts on the poor (Kandil 2010; Salehi-Isfahani 2016). New targeted measures to mitigate the impact of energy price increases on the poor, such as targeted (conditional) cash transfers have worked well in countries like Brazil, Indonesia, Mexico, and Turkey. Other countries have expanded existing programs and improved their targeting, such as school meals, public works, reduction in education and health fees, or subsidized mass transportation in countries like Mozambique, Ghana, Niger, and Nigeria (Coady et al. 2015). Drawing on these experiences, Egypt chose a “mixed approach”, both increasing existing programs, especially food subsidies, and introducing a new cash program, Takaful and Karama.

The next section will discuss the energy subsidy reform and devaluation in more detail,

Energy subsidy reform and devaluation in Egypt

Before energy subsidies and, specifically, fuel subsidies were first reduced in 2014,[7] fuel and electricity subsidies together accounted for 21.9 percent of total government expenditure and 6.0 percent of GDP (Figure 2.1). Since 2013/14, the share of energy subsidies in government expenditure has steadily declined and the investment share in expenditure has constantly increased. The share of government expenditures made up by food subsidies remained relatively constant, while that for cash transfer program, Takaful and Karama, has steadily increased since its introduction in 2015.

Figure 2.1. Energy subsidies, food subsidies, and investment, 2012/13 to 2017/18, as a percentage of total government expenditure



*Projected

Source: Ministry of Finance, 2018, Monthly bulletin. Note: T&K = Takaful and Karama.

During the first wave of subsidy cuts in 2014, the GOE introduced substantial fuel price increases – a 64 percent increase in diesel prices; 78 percent increase in the price for gasoline 80; a 40 percent increase in gasoline 92 prices; and a six-fold increase in prices for the largest residential users of natural gas. Heavily subsidized Liquefied Petroleum Gas (LPG) was excluded from the subsidy cut (IMF 2015).[8]

The decline in international prices in late 2014 and early 2015 reduced the gap between international and domestic prices, offering a good opportunity to adopt a more sustained program of fuel subsidy cuts. Figure 2.1 shows the declining share of energy subsidy as a percentage of total government expenditures. The fiscal savings were estimated at around 44 billion Egyptian pounds,

[7] Before the GOE announced a scheduled program to phase out energy subsidies in 2014, the domestic prices of fuel products were kept constant until 2004, when the government started to increase the prices of some products (Abouleinein et al. 2009). Partial attempts to phase out fuel subsidy were implemented in 2012 and 2013: a 220 percent increase in the price of LPG, and full cost recovery prices for gasoline 95. Natural gas prices increased also for residential and industrial uses and small increases in the prices of gasoline 80/92 and diesel (IISD 2014). However, the subsidy to cost ratio remained particularly high for LPG (around 81 percent), followed by diesel (about 58 percent) and gasoline (44 percent) (MoF 2012).

[8] As a result of the fuel price hikes, the inflation rate went from 10.1 percent in 2013/14 to 11.8 percent in October 2014. However, the inflation rate decreased to 10.1 percent in December 2014 due to interest rate action by the Central Bank of Egypt (IMF 2015).

but the fiscal space was still limited by the high costs for debt service and large wage bills (IMF 2016).

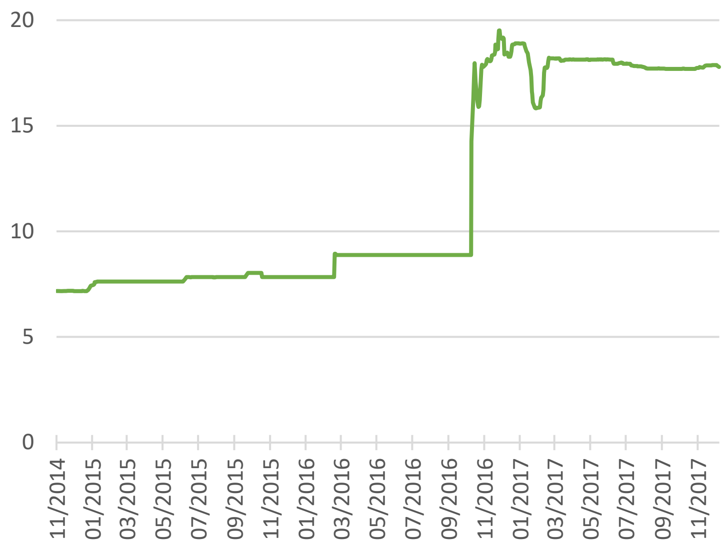
Table 2.1. Subsidy by type of fuel, 2014/15

	Diesel (solar)	Gasoline	LPG	Kerosene	Mazot (Fuel oil)
Total annual subsidy (million EGY pounds)	44,904	20,147	19,116	53	16,031
Share in total fuel subsidy (percent)	44.8	20.1	19.1	0.1	16.0
Total sales revenues (million EGY pounds)	25,120	14,335	1,120	26	28,860
Total cost (million EGY pounds)	70,024	34,482	20,236	79	44,891
Share of subsidy to cost	64.1	58.4	94.5	67.1	35.7

Sources: MoF, 2014. Note: LPG = Liquefied Petroleum Gas.

However, after the 2014 reform, fuel products still remained heavily subsidized, especially for LPG, diesel, kerosene, and gasoline, as shown by the share of subsidy to cost ratios (Table 2.1). Hence, the government continued its firm commitment towards fiscal reform by further cutting fuel subsidies.[9] In 2016 and 2017, the LPG price was raised by around 87.5 percent and then 100 percent, respectively, gasoline 80 by 46.9 and 55.3 percent, gasoline 92 by 34.6 and 43.0 percent, diesel by 30.6 and 55.3 percent; and Mazot (fuel oil) by around 40 percent in 2017. Electricity prices also increased by around 30 and 40 percent in 2016 and 2017, respectively.[10] Following these measures, the fiscal deficit for FY 2016/17 was reduced to 10.9 percent as a share of GDP (MoF 2017). Nevertheless, fuel still remains heavily subsidized, largely as a consequence of the floatation of the exchange rate in November 2016. Therefore, after several years of decline, the share of energy subsidies in government expenditures is projected to increase again from 6.4 percent to 11.6 percent between 2017/18 (Figure 2.1).

Figure 2.2. Exchange rate for Egyptian pound (EGP) to US dollar (USD) over period 2014 to 2017



Source: Central Bank of Egypt, 2018

[9] The fiscal reform has also included the implementation of the VAT. About 1 percent of GDP as fiscal savings have been directed to increase food subsidies and cash transfers to the vulnerable groups.

[10] The main sources of information on price changes of energy commodities over the period 2014 to 2017 included several decrees of the Ministry of Petroleum, reports of the Ministry of Electricity, IMF reports, and several issues of Egypt Oil & Gas newsletters.

The currency devaluation became necessary as Egypt's international position encountered a fundamental disequilibrium. After a period of volatility, the exchange rate stabilized at about EGP 18.0 per USD 1.0 compared to EGP 8.8 before the float (Figure 2.2) (IMF 2018). Economic theory and empirical evidence shows that, following such a devaluation, relative prices usually divert consumption towards lower priced, domestically-produced goods and services and make exports more competitive. As with energy subsidy cuts, however, large currency devaluations often lead to a short-term reduction in economic output, higher prices for imported goods and declining real incomes (Copper 1971; Bussière et al. 2010; Kandil 2011). Indeed, early evidence suggests that Egypt is no exception. As of July 2017, the trade balance deficit had decreased by around 8.4 percent due to an increase in export earnings by nearly 16 percent and a decrease in imports by 0.5 percent. In addition, international currency reserves more than doubled by October 2017, reaching 36.7 billion USD compared to 17.5 billion USD in June 2016, equivalent to more than seven months of import coverage (CBE 2017). Confidence in the Egyptian pound has also returned and US dollar shortages in the banking system have been eliminated. However, depreciation sharply increased inflation during the first year following the exchange rate reform, likely affecting households' purchasing power and real incomes significantly. By the beginning of 2018, inflation had been significantly reduced and stabilized.

To get a first "feel" as to how these significant changes in energy subsidy policy and exchange rates may have affected the Egyptian economy and households, the next section provides an overview of the role of energy in the Egyptian economy as a background for the following economy-wide analysis.

Overview of the role of energy in the Egyptian economy

We first provide a summary of the most important structural features of the Egyptian economy and related elasticities, which together determine the results of the DCGE-based simulations (Tables 2.2 to 2.4). Columns [1] and [2] of Table 2.2 describe the structure of production across economic sectors in fiscal year 2012/13, i.e. shortly after the 2011 Egyptian revolution and immediately before the beginning of the reform process.

The structure of gross output reveals the typical composition of production often found in middle-income, semi-industrialized countries, where agriculture still constitutes a relatively large share of gross domestic output. Egypt's agricultural value-added as a share of GDP is about 10 percent – lower than for lower middle-income countries, but higher than for MENA countries. Energy production makes up 20 percent of total production in Egypt, with crude oil, natural gas, petroleum products, and electricity contributing 5.6, 3.1, 9.0, and 2.9 percent, respectively.

The importance of intermediate energy inputs for each sector is indicated by the per-unit total intermediate input coefficients in column [3] in combination with the energy input shares in column [4]. As shown in columns [4] and [5], energy inputs make up a large share of total production cost in natural gas, manufacturing of textiles and of non-metallic mineral products, as well as in electricity production and the transport sector. This implies that any rise in energy prices as a result of the energy price reforms increases intermediate input costs in these sectors, thereby hampering the competitiveness of energy-intensive sectors both on international markets for commodities and on national markets for factors of production.

Table 2.2. Structure of supply

	Initial output 2012/13, billions EGP	Output share, percent	Per-unit total intermediate input share, percent	Per intermediate input energy share, percent	Per-unit energy share, percent	Per-unit hired labor share, percent	Per-unit family labor share, percent	Per-unit capital share, percent	Per-unit land share, percent	Partial supply elasticity, εS
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1 Agriculture	286.0	9.4	42.6	18.5	7.9	16.8	41.8	27.8	13.6	0.12
2 Forestry	0.1	0.0	15.3	10.2	1.6	89.0		11.0		0.62
3 Fishing	18.3	0.6	11.0	9.6	1.1	21.4		78.6		0.15
4 Crude oil	169.8	5.6	7.0	19.0	1.3	1.6		98.4		0.01
5 Natural Gas	94.1	3.1	39.1	73.0	28.5	5.4		94.6		0.04
6 Metal ore mining	1.9	0.1	4.6	21.0	1.0	8.1		91.9		0.06
7 Other mining	12.3	0.4	59.7	11.6	6.9	12.4		87.6		0.09
8 Mining support	32.7	1.1	26.8	1.1	0.3	1.1		98.9		0.01
9 Food processing	161.2	5.3	80.0	5.9	4.7	30.2	41.9	27.9		0.21
10 Beverages	17.4	0.6	69.8	3.5	2.4	16.7	50.0	33.3		0.12
11 Tobacco	6.3	0.2	62.7	5.8	3.6	47.1	31.7	21.2		0.33
12 Textiles	19.0	0.6	65.6	23.0	15.1	61.6	23.0	15.4		0.43
13 Clothing	22.7	0.7	49.7	8.3	4.1	25.0	45.0	30.0		0.18
14 Leather	6.0	0.2	43.5	6.7	2.9	20.4	47.8	31.8		0.14
15 Wood processing	5.0	0.2	57.7	11.6	6.7	39.1	36.5	24.4		0.27
16 Paper	11.5	0.4	74.6	7.2	5.4	28.6	42.8	28.6		0.20
17 Petrol refining	271.8	9.0	67.3	4.2	2.8	7.0		93.1		0.05
18 Chemicals	86.6	2.9	47.0	20.0	9.4	14.9		85.1		0.10
19 Non-metallic mineral products	50.8	1.7	48.7	51.1	24.9	16.0	50.4	33.6		0.11
20 Basic metals	129.0	4.3	71.2	11.7	8.3	19.1	48.5	32.4		0.13
21 Equipment	21.9	0.7	57.1	9.7	5.5	18.7	48.8	32.5		0.13
22 Machinery	8.2	0.3	73.1	8.3	6.1	57.7	25.4	16.9		0.40
23 Vehicles	10.7	0.4	80.4	8.2	6.6	42.2	34.7	23.1		0.30
24 Other manufacturing	63.7	2.1	49.0	7.6	3.7	13.1	52.1	34.7		0.09
25 Electricity	87.1	2.9	86.3	94.9	81.8	98.9		1.1		0.69
26 Water	14.3	0.5	18.5	39.9	7.4	47.8		52.2		0.33
27 Construction	213.0	7.0	47.8	11.6	5.6	8.4	55.0	36.7		0.06
28 Trade	277.7	9.2	12.7	47.3	6.0	10.0	54.0	36.0		0.07
29 Transport	148.2	4.9	28.6	67.3	19.2	21.1	47.3	31.5		0.15

	Initial output 2012/13, billions EGP	Output share, percent	Per-unit total intermediate input share, percent	Per intermediate input energy share, percent	Per-unit energy share, percent	Per-unit hired labor share, percent	Per-unit family labor share, percent	Per-unit capital share, percent	Per-unit land share, percent	Partial supply elasticity, εS
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
30 Hotels	32.1	1.1	21.0	15.8	3.3	16.1	50.4	33.6		0.11
31 Communications	56.2	1.9	26.7	7.6	2.0	11.7	53.0	35.3		0.08
32 Financial services	63.0	2.1	15.4	8.8	1.4	48.4	31.0	20.6		0.34
33 Real estate	140.0	4.6	15.8	2.2	0.3	2.7	58.4	38.9		0.02
34 Business services	27.5	0.9	15.6	7.3	1.1	16.2	50.3	33.5		0.11
35 Public administration	117.5	3.9	27.1	11.6	3.1	94.0		6.0		0.66
36 Education	89.4	3.0	10.2	7.5	0.8	78.0		22.0		0.55
37 Health	64.8	2.1	27.4	8.7	2.4	51.2		48.8		0.36
38 Other services	193.7	6.4	35.3	14.7	5.2	28.8	42.7	28.5		0.20
TOTAL	3031.5	100.0				22.5	31.7	44.5	1.2	

Source: Egypt DCGE model

Table 2.3. Demand structure and foreign trade

	Export share, percent	Export-output share, percent	Import share, percent	Import-demand share, percent	Imported-total intermediate input share, percent	Own-price elasticities of demand: Urban households: from lowest to highest quintile	Own-price elasticities of demand: Rural households: from lowest to highest quintile	Trade elasticities: Identical transformation & substitution elasticities: σ_q and σ_q
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1 Maize			2.7	36.6	14.2	-0.107	-0.181	-0.097	-0.122	1.30
2 Rice					14.2	-0.111	-0.182	-0.078	-0.116	5.05
3 Wheat			4.0	49.9	14.2	-0.110	-0.181	-0.094	-0.120	4.45
4 Other cereals	0.0	3.1	0.0	12.3	14.2			1.30
5 Vegetables			0.7	9.5	14.2	-0.084	-0.111	-0.089	-0.105	1.85
6 Fruits and nuts	2.1	4.5	0.6	11.1	14.2	-0.183	-0.282	-0.153	-0.214	1.85
7 Oil seeds	0.2	15.4	1.6	80.8	14.2	-0.115	-0.193	-0.092	-0.138	2.45
8 Living plants	0.1	22.1	0.1	71.7	14.2	-0.106	-0.181	-0.075	-0.114	2.45
9 Plants used for sugar manufacturing					14.2	-0.132	-0.225	-0.121	-0.181	2.70
10 Unmanufactured tobacco	0.0	83.9	0.1	99.9	14.2	-0.096	-0.165	-0.097	-0.146	3.25

	Export share, percent	Export-output share, percent	Import share, percent	Import-demand share, percent	Imported-total intermediate input share, percent	Own-price elasticities of demand: Urban households: from lowest to highest quintile	Own-price elasticities of demand: Rural households: from lowest to highest quintile	Trade elasticities: Identical transformation & substitution elasticities: σ_q and σ_q
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
11 Beverages and spice crops	0.8	4.5	0.8	10.2	14.2	-0.153 | -0.255	-0.101 | -0.150	3.25
12 Wood and other forestry products	0.0	31.9	0.2	93.4	2.9	-0.094 | -0.161	-0.067 | -0.101	2.50
13 Live animals			0.2	1.0	14.2	-0.178 | -0.302	-0.137 | -0.201	2.00
14 Fishes					0.1	-0.133 | -0.211	-0.097 | -0.141	1.25
15 Coal and lignite; peat	0.1	62.2	0.1	83.5	14.3		-0.101 | -0.101	3.05
16 Crude oil	6.1	12.0	4.3	13.1	14.3			5.20
17 Natural gas	3.2	11.0			7.1	-0.114 | -0.170	-0.080 | -0.118	17.20
18 Metal ores and other minerals	1.3	28.5	1.1	35.9	19.3	-0.201 | -0.342	-0.511 | -0.77	0.90
19 Meat, fish, fruits, vegetables products	1.4	15.7	5.5	62.3	5.8	-0.187 | -0.272	-0.155 | -0.198	2.00
20 Food oil	0.2	2.2	0.1	1.5	0.7	-0.120 | -0.195	-0.100 | -0.144	3.30
21 Dairy products	0.8	14.7	1.1	34.4	21.6	-0.150 | -0.241	-0.109 | -0.158	3.65
22 Flour, rice	0.6	5.9			21.6	-0.113 | -0.182	-0.088 | -0.134	2.60
23 Sugar	0.4	8.0	0.1	4.1	21.6	-0.137 | -0.226	-0.126 | -0.184	2.70
24 Pasta and tea and other food products	1.5	6.7	1.7	13.5	21.6	-0.207 | -0.277	-0.134 | -0.164	2.00
25 Beverages			0.1	1.9	18.7	-0.164 | -0.271	-0.106 | -0.160	1.15
26 Tobacco products	0.3	7.2	0.5	42.9	55.2	-0.112 | -0.170	-0.112 | -0.155	1.15
27 Yarn and textile	2.9	31.6	2.2	50.4	35.8	-0.198 | -0.322	-0.240 | -0.343	3.75
28 Knitted or crocheted fabrics;	2.9	19.6	0.8	22.4	32.9	-0.239 | -0.372	-0.175 | -0.244	3.70
29 Leather and leather products; footwear	0.3	14.7	0.2	23.7	28.1	-0.198 | -0.332	-0.141 | -0.208	4.05
30 Products of wood	0.0	2.3	1.9	67.6	38.9	-0.201 | -0.348	-0.511 | -0.774	3.40
31 Paper and paper products	0.9	11.9	2.1	38.4	31.2	-0.419 | -0.693	-0.350 | -0.521	3.40
32 LPG	0.6	5.3	2.6	26.8	14.6	-0.103 | -0.162	-0.075 | -0.104	2.10
33 Gasoline 80	1.2	12.5	3.2	38.3	14.6	-0.129 | -0.233	-0.101 | -0.156	2.10
34 Gasoline 90/92	1.3	12.5	3.7	38.3	14.6	-0.129 | -0.235	-0.101 | -0.156	2.10
35 Gasoline 95	0.0	12.5	1.8	98.3	14.6	-0.174 | -0.220	-0.135 | -0.157	2.10
36 Kerosene	0.6	99.5	1.6	99.9	14.6	-0.096 | -0.161	-0.070 | -0.103	2.10
37 Solar	2.3	6.0			14.6	-0.098 | -0.173	-0.076 | -0.107	2.10
38 Mazot (heavy fuel oil)	1.0	6.0			14.6	-0.095 | -0.171	-0.068 | -0.107	2.10
39 Glass and glass products	2.7	13.3	0.7	9.1	38.2	-0.371 | -0.608	-0.295 | -0.422	3.30
40 Basic chemicals and other chemical products	10.5	34.8	13.9	58.2	38.2	-0.134 | -0.203	-0.108 | -0.15	3.30

						Own-price elasticities of demand		Trade elasticities
	Export share, percent	Export-output share, percent	Import share, percent	Import-demand share, percent	Imported-total intermediate input share, percent	Urban households: from lowest to highest quintile	Rural households: from lowest to highest quintile	Identical transformation & substitution elasticities: σ_q and σ_q
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
41 Basic metals	8.7	19.2	10.3	33.4	27.6	-0.259 | -0.364	-0.610 | -0.801	4.20
42 Radio, television and communication equipment and apparatus	0.3	14.7	2.1	74.2	36.3	-0.141 | -0.240	-0.212 | -0.321	4.05
43 Electrical machinery and apparatus	2.9	32.1	12.5	80.2	26.1	-0.147 | -0.249	-0.220 | -0.332	4.05
44 Transport equipment	0.4	8.8	4.9	75.7	41.9	-0.187 | -0.343	-0.144 | -0.222	2.80
45 Furniture	0.8	11.5	0.6	19.1	36.5	-0.207 | -0.348	-0.523 | -0.78	3.75
46 Electricity transmission and distribution					13.8	-0.107 | -0.168	-0.076 | -0.106	2.80
47 Water distribution					11.5	-0.104 | -0.172	-0.079 | -0.117	2.80
48 Construction services	1.1	1.7	0.4	0.9	14.0	-0.144 | -0.245	-0.215 | -0.326	1.90
49 Wholesale and retail trade services					13.3	-0.207 | -0.341	-0.167 | -0.249	1.90
50 Transport services	16.7	29.8	1.0	3.7	24.9	-0.196 | -0.362	-0.183 | -0.285	1.90
51 Lodging	18.7	74.5	3.1	43.5	25.7	-0.154 | -0.241	-0.113 | -0.164	1.90
52 Telecommunications services	1.7	9.2	0.4	3.7	20.5	-0.285 | -0.445	-0.192 | -0.277	1.90
53 Financial intermediation	0.6	2.9			14.6	-0.225 | -0.371	-0.178 | -0.265	1.90
54 Real estate services					20.4	-0.205 | -0.283	-0.127 | -0.156	1.90
55 business services	1.3	7.4	3.2	23.4	22.6	-0.207 | -0.343	-0.174 | -0.257	1.90
56 Public administration services	0.8	2.2	1.5	6.1	4.7	-0.202 | -0.343	-0.169 | -0.25	1.90
57 Education services					16.5	-0.300 | -0.501	-0.265 | -0.398	1.90
58 Health and social services					26.5	-0.251 | -0.402	-0.222 | -0.332	1.90
59 Other services					17.3	-0.211 | -0.363	-0.175 | -0.273	1.90
Total	100.0	9.7	100.0	17.5				

Source: Egypt DCGE model

Table 2.4. Structure of household income and expenditures

	Household income (percentage share of total)								Household expenditures (percentage share of total)			
					Net transfers from			Total				
	Hired labor	Family labor	Capital profits	Land	Enter-prises	Govern-ment	Abroad [c]	Billions EGP	Energy [a]	Non-energy	Taxes	Savings [d]
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
All households [b]	18.55	15.05	9.46	1.28	48.77	0.28	6.61	1,749.69	9.2	71.9	2.2	16.7
Urban households	14.51	11.09	7.39	0.76	61.94	0.36	3.95	904.07	9.5	69.9	2.4	18.2
Urban poor households	23.49	39.56	8.86	0.41	24.87	0.29	2.51	165.95	8.6	75.3	2.2	13.9
Urban middle-income households	18.68	6.26	8.03	0.56	62.97	0.37	3.14	297.81	9.1	73.2	2.4	15.2
Urban high-income households	8.30	3.63	6.41	1.02	75.22	0.38	5.04	440.31	10.1	65.6	2.5	21.8
Rural households	22.87	19.28	11.67	1.84	34.69	0.20	9.46	845.62	8.8	74.0	2.1	15.1
Rural poor households	30.47	32.02	12.85	0.68	10.99	0.17	12.82	192.27	7.0	82.1	2.5	8.5
Rural middle-income households	26.36	16.75	13.18	1.40	32.83	0.17	9.33	314.24	9.1	76.2	2.1	12.6
Rural high-income households	15.32	14.41	9.61	2.90	49.84	0.25	7.67	339.11	9.6	67.4	1.7	21.3

Note: Numbers are based on base year model solution.
[a] Estimates of energy consumption shares may differ from purely household survey-based estimates. This is because the underlying SAM combines information from the Ministry of Petroleum on total household consumption of fuel with shares derived from the household survey (see section 3 for more details).
[b] Poor households refer to the lowest two quintiles in the household income distribution. Middle-income households are those in the third and fourth quintiles. High-income households refer to the fifth quintile.
[c] Net transfers from abroad, including remittances, but also interest payments or receipts on private assets or liabilities.
[d] Savings are calculated residually as difference between total income and recurrent expenditures on income taxes, consumption, and transfers.

Each sector's use of labor, capital, and land is an important determinant of the distributional implications that changes in the respective sector's output have on households (Table 2.2, Columns [6] to [9]).[11] Not surprisingly, self-employed and family workers dominate in agriculture and more informal sectors, whereas family labor does not play a significant role in the mining, chemical, utility, and public services sectors that are more dominated by capital and formal employment. As expected, agriculture and agricultural processing sectors as well as services are among the most labor-intensive sectors, while the mining, chemicals, petrol, and water sectors are among the most capital-intensive sectors, with other industries are somewhere in between.

The supply elasticities determine the sectoral results of reform simulations in the model (Table 2.2, Column [10]). Because production technology for sectoral value-added is modelled by two-level constant elasticity of substitution (CES) production functions, the shares observed in the benchmark equilibrium data together with the factor substitution elasticities provide us with a set of partial labor demand and output elasticities. Given this technology specification and identical factor substitution elasticities of 0.7 for any pair of primary factors in all production sectors, price elasticities are highest in hired-labor-intensive sectors with a large share of hired labor value-added in total value-added, such as forestry, electricity, or textiles.

The impact of energy price changes and currency devaluation are also expected to differ depending on a sector's trade orientation and the structure of final demand (Table 2.3). Column [1] in Table 2.3 indicates that 24 out of the 44 tradable-producing sectors export more than 10 percent of their output, with tobacco, coal, kerosene, and hotel services being the most export-oriented sectors in the economy. By international standards, export ratios are low and reflect a country with a large domestic market and a relatively inward-looking development strategy (Nin Pratt et al. 2018). On the import side, a mixed picture emerges when one considers both the share of imports in domestic demand, which indicates the degree of "import orientation", and the share of imported intermediate inputs in total intermediate inputs, which indicates the degree of "import dependence". Food crop sectors and "other industry" are the most import-oriented sectors, while most agricultural and food processing sub-sectors are highly import-dependent. Rice, sugar, fish, electricity, water, trade, real estate, and other services are the only sectors with no or little international trade, yet 26 percent of total intermediates used in the health sector are imported. Thus, devaluation is expected to have a strong negative indirect impact, including in non-tradable sectors.

The foreign trade elasticities used in the simulations (column [8] in Table 2.3) capture the extent of product differentiation due to differences in quality and degree of product homogeneity. These elasticities are taken from the Global Trade Analysis Project (GTAP) data set (Aguiar et al. 2016) and are generally higher for primary goods than for manufactured goods and services. We assume identical import substitution and export transformation elasticities for individual goods. Together with the trade shares shown in columns [2] and [4], these trade elasticities determine the sectors' trade adjustment flexibility to terms-of-trade-shocks.[12]

[11] In the model, hired labor is differentiated by three skill categories (unskilled, semi-skilled, skilled) and two regions (urban and rural).

[12] These trade elasticities reflect the change in relative demand or supply from/for the domestic and world market as a result of changes in relative prices for domestically produced goods and traded goods of the same product category. Thus, the high import substitution and identical export transformation elasticity of 5.05, implies that a one percent increase in the world market price for wheat compared to the price on the domestic market would, ceteris paribus, lead to a 5.05 percent increase in imported/exported wheat relative to demand/supply from/to the world market. By contrast, trade elasticities below one imply relative weak quantity changes as a result of relative price changes.

On the demand side, (i) the demand for intermediate goods is modeled as Leontief technology and therefore is not price sensitive, (ii) investment demand is specified by fixed capital composition shares, and (iii) government consumption demand is determined exogenously. The partial equilibrium price elasticity of demand for the composite good in each sector is almost completely determined by the price elasticity of consumer demand. Consumer demand is derived from a Linear Expenditure System (LES) with exogenously estimated income elasticities of demand. The resulting partial own-price elasticities are shown in columns [6] and [7]. Own-price elasticities of demand for energy goods are generally absolutely lower for rural than for urban households and within each region are lower for poorer than for richer households, implying higher direct welfare losses for rural compared to urban households and for poorer compared to richer households, as a result of higher consumer prices for energy.[13]

The main impact transmission channels for households are through changes in factor remuneration on the income side and through changes in consumer prices on the expenditure side. Moreover, devaluation affects household welfare via changes in transfers from abroad, which are fixed in foreign currency and increase in domestic currency with the devaluation of the EGP. Table 2.4 summarizes income and expenditure patterns for urban and rural households.

Poor households, which make up 40 percent of total population (according to a $2 a day poverty line), account for about 20 percent of total household income, whereas the population and income shares are 57 percent and 48 percent for rural households and 43 percent and 52 percent for urban households. The sources of household incomes are strongly related to factor and human capital endowments. Rural households receive most of their income from the provision of labor (more than 40 percent), both as family (20 percent) and hired (23 percent) labor, while labor income makes up only 25 percent of total urban income. Yet, labor income is the dominating income source of poor households, both rural and urban. In addition, rural households are the primary recipients of remittances from abroad. Moreover, per-capita remittances are higher for poorer than for richer rural households. Thus, poor rural households are expected to partly benefit from higher remittances in local currency as a result of devaluation. On the expenditure side, the major difference between households is that urban households spend a slightly larger share of their earned income on energy, including electricity, compared to rural households, and this share is generally larger for richer than poorer households in both regions.

This overview of key structural features of the Egyptian economy and households has provided important insights into possible distributional outcomes of the economic reform package. The next section will describe the methodology that will allow for quantifying these outcomes based on a dynamic computable general equilibrium (DCGE) model.

3. AN ENERGY-FOCUSED DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR EGYPT

Data and model

As the basis of our analysis we augment the Social Accounting Matrix 2012/13 for Egypt aggregated by the Central Agency for Public Mobilization (CAPMAS) with data from the Ministry of Petroleum

[13] The PSIA study mentioned above estimates direct welfare losses of -2.45 percent for all households and -2.97 for the bottom quintile with zero price elasticities. These results can be interpreted as upper bounds because the price elasticity of consumption is assumed to be zero. Applying a price elasticity of electricity (gasoline) consumption equal to -0.33 (-0.21) would lead to an average total direct effect of -1.92 percent, with the bottom quintile experiencing a loss of -2.43 percent.

and a previous energy-focused social accounting matrix (SAM) 2010/11 by Griffin et al. (2016). Key changes include:

- The SAM has been re-arranged and aggregated to be consistent with IFPRI's SAM and the structure of the DCGE model.
- The intermediate consumption matrix for fuel has been disaggregated and now consists of LPG; gasoline 80, 90, 92, and 95; kerosene; diesel; and "other fuels" commodities. In doing so, first, we use the SAM 2010/11 developed by Griffin et al. and split diesel fuel from other fuels using aggregate numbers provided by the Ministry of Petroleum. Then we split "other fuels" according to the shares that were calculated using the data of the Ministry of Petroleum. In doing so, we assume that all SAM sectors follow the national fuel input distribution. Yet, sectoral differences in overall fuel intensities as well as natural gas and electricity intensities imply that production sectors are affected quite differently by the fuel subsidy reform.
- For the final household consumption matrix, we used the aggregate final consumption numbers from the Ministry of Petroleum and then split the various fuel types across ten household types by using shares from the 2012/13 Household Income and Expenditure (HIECS) survey leading to varying budget shares for energy items both across energy sources and across households.[14]

The resulting SAM has 38 production activities; 59 commodities; 11 factors of production; 10 household types (rural and urban and by expenditure quintile); various tax accounts, including sales subsidies; savings/investment account; enterprise account; and the rest of the world account. Because the focus of this paper is on energy, the multi-sectoral DCGE model has a special emphasis on energy-related activities and their linkages to other production sectors*.* A sectoral distinction is made within industry between energy-producing sectors (*crude oil, natural gas, petrol, and electricity*), energy-dependent sectors (*textiles; non-metallic mineral products; electricity; and water collection, treatment, and supply*) and other industrial sectors. Finally, there are eleven service sectors, two of them (wholesale and retail trade, and transport) being highly dependent on energy intermediate inputs. An aggregate version of the SAM can be found in Appendix 1. It should be noted that the constructed SAM might not reflect true financial costs of energy subsidies. This is due to the fact that disaggregated data for these costs are difficult to obtain and may imply that the true subsidy rates are higher than the ones calculated based on the SAM constructed by CAPMAS. As this caveat is likely to cause unrealistic adjustments of the budget deficit over the simulation period, we assume that the reduction of the budget deficit is fixed over time. The implication of this approach is that the model and the interpretation of results focuses on the real economy and households rather than on fiscal developments.

The DCGE model is based on this SAM to represent the initial equilibrium position of the Egyptian economy and provides numerical values to several key parameters of the analytical model. The analytical model belongs to a class of dynamic planning models developed by Dervis et al. (1982). The model used here to investigate the short and long-term impacts of energy subsidies and devaluation follows a standard specification as documented in Diao and Thurlow (2012). One distinguishing characteristic of this type of model is its rooting in microeconomic theory: Producers minimize costs subject to certain technology constraints and prices, while consumers maximize

[14] Household expenditures for energy (natural gas, fuels, and electricity) make up 11.3 percent of total household consumption with energy shares ranging from 0.3 percent for kerosene or gasoline95 to 3 percent for natural gas, and household budget shares ranging from 7.6 percent for rural households in the second lowest quintile to 13.3 percent for urban households in the highest quintile. Moreover, expenditure shares for energy goods differ within households.

utility subject to a budget constraint and prices, with prices of energy goods diverging from world market prices and cost recovery prices. Another trait is the detailed attention devoted to income and expenditure flows, including the extended functional distribution of factor income across sectors and the distribution of functional income to the owners of factors, i.e. different households, which allows for impact analysis. SAMs rather than input-output tables provide the structural backbone of these models.[15]

While the core equations of the model are summarized in Table 3.1, the following bullet points describe the Egypt-specific features of the model and those parts of the Diao-Thurlow model that are most relevant for the subject of this paper, namely the impacts of changing local energy prices and of the devaluation of the Egyptian Pound.

- Producers in the model are price takers in output and input markets and maximize profits using constant returns to scale technologies. Primary factor demands are derived from constant elasticity of substitution value-added functions, while intermediate input demand by commodity group is determined by a Leontief fixed-coefficient technology. Exceptions are crude oil and natural gas production, for which production is determined by Egypt's conservation and export strategies for natural resources. For these two energy sectors, output is determined exogenously by given investments under Leontief production technology for both intermediate inputs and primary factors.
- The decision of producers between production for domestic and foreign markets is governed by constant elasticity of transformation functions that distinguish between exported and domestic goods in each traded commodity group. Under the small country assumption, Egypt faces perfectly elastic world demand curves for its exports at fixed world prices. The revenue-maximizing equilibrium ratio of exports to domestic goods in any traded commodity group is determined by the relative prices for these two commodity types. Again, the exceptions are crude oil and natural gas, for which exports are determined residually as the difference between exogenous supply and endogenous domestic demand.
- On the demand side, imported and domestic goods are treated as imperfect substitutes in both final and intermediate demand. In line with the small country assumption, Egypt faces an infinitely elastic world supply at fixed world prices. The equilibrium ratio of imports to domestic goods is determined by the cost-minimizing decisions of domestic consumers based on relative tax- and subsidy-inclusive prices of imports and domestic goods

[15] Like any other economic model, the DCGE model also has its limitations (see Breisinger et al 2011, among others). Of these, there are at least four limitations or caveats that are important to note when interpreting the results of this paper.

1. The dataset for DCGE modeling analysis, the Social Accounting Matrix (SAM), is constructed from one year's data. This contrasts with a typical econometric analysis in which either time-series or cross-sectional data are used to estimate the causality relationships between economic and social variables.
2. Although income elasticities of demand in the model are econometrically estimated and subsistence consumption is taken into account in the demand functions, the use of a linear expenditure system to specify household demand can only partially capture demand dynamics.
3. Production technologies that are calibrated to the initial economic conditions remain constant over time. As in the demand system, the production functional forms, including the parameters and elasticities, are given.
4. Although the model captures the market equilibrium and linkages between domestic and foreign markets, it does not consider the role of market institutions and other players along the supply chains.

Table 3.1. Equations of the Egypt dynamic Computable General Equilibrium model

I. Prices

(1) $PM_i = pwm_i(1 + tm_i)\overline{R}$

(2) $PE_i = pwe_i/(1 + te_i)\overline{R}$

(3) $PQ_i = f(PM_i, PD_i)$

(4) $PX_i = g(PE_i, PD_i)$

(5) $PV_i = PX_i - \sum_j a_{ij} PQ_i$

(6) $CPI = \sum_i \Omega_i PQ_i$

(7) $DPI = \sum_i \Psi_i PD_i$

II. Production, employment, and wage rates

(8) $QX_i = f(\overline{K}_i, L_{fi})$

(9) $W_f = PV_i(\delta QX_i/\delta L_{fi})$ f= labor, land

(10) $LD_f = \sum_{i}, L_{fi}$

(11) $LD_f - \overline{LS_f} = 0$

III. Foreign trade

(12) $E_i = h(PE_i/PD_i)$

(13) $M_i = m(PM_i/PD_i)$

(14) $\sum_i pwm_i M_i - \sum_i pwe_i E_i - \overline{F} = 0$

IV. Income and flow of funds; endogenous variables calculated

(15) Y_h: income of households

(16) Y_G: government revenues

(17) S: total investment

IV. Sectoral demand and product markets

(18) $I_i = \phi_i S$

(19) $Z_i = \sum_j b_{ij} I_j$

(20) $V_i = \sum_j a_{ij} QX_j$

(21) $C_i = \sum_h q_{ih} (1 - s_h) Y_h / PQ_i$ j=g, G

(22) $D_i = d_i(V_i + C_i + Z_i)$

(23) $d_i = 1/f_i(M_i/D_i, 1)$

(24) $XD_i = D_i + E_i$

(25) $XD_i - QX_i = 0$

V. Dynamics

(26) $LS_{ft} = LS_{ft-1}(1 + \varphi_f)$

(27) $LS_{ft} = LS_{ft-1}(1 - \eta) + \sum_i \frac{PQ_{ft-1} I_{ft-1}}{\kappa} \varphi_f$

(28) $\alpha_{it} = \alpha_{it-1}(1 + \gamma_i)$

<u>Subscripts</u>

f	factor groups (labor, capital, and land)
h	household groups
i,j	sectors
t	time periods

<u>Exogenous variables</u>

$\overline{R}$	nominal exchange rate
$\overline{F}$	foreign savings balance
pwm	world import prices
pwe	world export prices

<u>Exogenous parameters</u>

α	factor productivity
Ω	consumer price index weights
Ψ	producer price index weights
ϕ	investment allocation shares
b	capital composition coefficients
a	input-output coefficients
q	expenditure shares
s	savings rates
tm	tariff rate
te	export subsidy rate
φ	land and labor supply growth rate
η	capital depreciation rate
γ	Hicks neutral rate of technical change
κ	base price per unit of capital stock

<u>Endogenous variables</u>

PM	import price
PE	export price
PQ	commodity price
PX	output price
PV	unit value-added
CPI	consumer price index
DPI	producer price index
QX	output quantity
M	import quantity
E	export quantity
L	labor and land demand quantity
W	average factor return
L	factor demand quantity
Y	household income
YG	government revenue
S	total investment
I	investment by sector of destination
Z	investment by sector or origin
V	intermediate demand
C	consumption demand
D	domestic demand
d	domestic demand ratio
XD	total demand for domestic output
f(−)	CES cost function
g(−)	CET revenue function

Source: Authors' compilation based on Diao and Thurlow (2012).

- There are seven labor groups: unskilled, semi-skilled, and skilled labor in both urban and rural regions. In addition, there is mixed or family labor which consists of smallholders (and family members) in agriculture and self-employed workers and their family members in manufacturing and services sectors. There are also three types of capital, which are exclusively used either in agriculture, mining, or other sectors. All labor types, except family labor, are fully employed and mobile across sectors in the long-run. This means that workers in each group receive the same wage in every sector. In the very short-run, economy-wide wages for hired labor are assumed to be fixed with labor demand determined by changes in sectoral real producer wages. Thus, increasing sectoral real producer wages (the relationship between wages and per-unit value-added) will lead to increasing unemployment and vice versa.
- Capital is assumed to be fixed and sector-specific in the short term, i.e., within individual periods, but new capital from past investment is allocated to sectors according to profit rate differentials under a "putty-clay" specification in the medium- to long-term. Again, the exceptions are crude oil and natural gas sectors, for which mining capital is allocated according to Egypt's investment plan.
- The level of foreign savings is assumed to be exogenous and fixed at the initial level. The level of investment is determined by the level of savings in the economy, the latter being the sum of private, public, and foreign savings.

The model's variables and parameters are calibrated to observed data from the national SAM that captures the initial equilibrium structure of the Egyptian economy in fiscal year 2012/13 (labelled 2012 in the model and the simulations). Parameters are then adjusted over time to reflect demographic and economic changes and the model is re-solved for a series of new equilibria for the period 2012 to 2025.[16] Between periods, the model is updated to reflect exogenous rates of land and labor expansion (and capital and output expansion in crude oil and natural gas production). The rate of capital accumulation is determined endogenously, with the level of investment from the previous period converted into new capital. The new capital is added to previous capital stocks after applying a fixed long-term rate of depreciation. Finally, the model captures total factor productivity through the production function's shift parameter, with the rate of technical change determined exogenously.

Specifications of the scenarios

In order to unpack the impacts of the economic reform package in Egypt, we design five different scenarios (Table 3.2). Each scenario is simulated for four different combinations of economic assumptions (closures):

- Two possibilities of the use of the government savings from the energy subsidy reform (saving-investment closure): a) Saved funds are used to finance investment exclusively; or b) saved funds finance both public investment and consumption.
- Two different assumptions for the labor markets: i) Labor supply adjusts to economic shocks, with wages being fixed. This specification allows the model to simulate unemployment and reflects short-term economic adjustment. And alternatively, ii) under the assumption of full employment, wages adjust to economic shocks and the growth of labor supply is restricted

[16] The simulation period covers the years 2012 to 2025, and we report results for two periods: (1) 2014 to 2017 – both short-run and long-run depending on labor market adjustments; and (2) 2012 to 2025 for the long-run impacts of the phasing out of energy subsidies.

by the growth rates of the population. These simulations reflect long-term economic developments.

Table 3.2. Economic scenarios and associated economic assumptions (closures).

Savings - Investment closures	a) Energy subsidy savings used to finance investment exclusively		b) Energy subsidy savings finance both public investment and consumption	
Scenarios	i) Short-term time horizon (unemployment)	ii) Short and long-term time horizons (full employment)	i) Short-term time horizon (unemployment)	ii) Short and long-term time horizons (full employment)
1. Base (reference)	Baseline scenario (BASE)	Baseline scenario (BASE2)	Baseline scenario (BASEa)	Baseline scenario (BASE2a)
2. Energy subsidy reform	Energy subsidy reform (ESR1)	Energy subsidy reform (ESR21)	Energy subsidy reform (ESR1a)	Energy subsidy reform (ESR21a)
3. Energy subsidy and devaluation reform	Energy subsidy and devaluation reform (ESR2)	Energy subsidy and devaluation reform (ESR22)	Energy subsidy and devaluation reform (ESR2a)	Energy subsidy and devaluation reform (ESR22a)
4. Energy subsidy, devaluation, and food subsidy reform	Energy, food subsidy, and devaluation reform (ESR3)	Energy, food subsidy, and devaluation reform (ESR23)	Energy, food subsidy, and devaluation reform (ESR3a)	Energy, food subsidy, and devaluation reform (ESR23a)
5. Energy subsidy, devaluation, food subsidy, and cash transfer reform	Energy, food subsidy, devaluation, and cash transfer reform (ESR4)	Energy, food subsidy, devaluation, and cash transfer reform (ESR24)	Energy, food subsidy, devaluation, and cash transfer reform (ESR4a)	Energy, food subsidy, devaluation, and cash transfer reform (ESR24a)

Source: Authors' presentation

Given different types of the economic assumptions/closures, each of the analyzed reform scenarios is considered as a counterfactual versus its own base (reference) scenario. Table 3.2 presents the summary mapping between economic scenarios and simulations.

Base (reference) scenario (BASE, BASE2, BASEa and BASE2a simulations): The reference scenario represents Egypt's economic development along its path in the absence of the reforms that were initiated in 2014. Most importantly, it is assumed that the government fully controls domestic prices of the fuel commodities. This means that within the framework of the DCGE model "base" simulations assume fixed prices of the fuel commodities for the whole simulation period.

Energy subsidy reform scenario (ESR1, ESR21, ESR1a and ESR21a simulations): Within this scenario, we consider two stages of the energy subsidy reform: the period 2014 to 2017 that simulates already observed price changes for the energy commodities, and the period 2014 to 2025 that in addition assumes further increase of energy prices until a complete phase out of the energy subsidies. It should be noted that the DCGE model and the SAM used in our analysis do not allow for the possibility for price discrimination, and all institutions are assumed to pay the same price for energy commodities. Accordingly, we introduce price changes in the model as uniform growth rates of average registered prices of energy commodities. Prices changes of the energy commodities (period 2014 to 2017) were calculated based on information from different sources that include several decrees of the Ministry of Petroleum, reports of the Ministry of Electricity, IMF reports and several issues of Egypt Oil & Gas newsletters (Appendix Table 2.1).

To simulate the complete phasing out of the energy subsidies, we make several important assumptions. First, we use information from the IMF country report (2017) that the price-to-cost ratio for gasoline and diesel reached 68 percent in 2017. Accordingly, we assume that the same price-to-cost ratio was reached by 2017 for all other energy commodities. Furthermore, we assume a linear one-to-one relationship between growth rates of the energy commodity prices and cost-recovery ratio. Last, but not least, we assume that the objective of 100 percent cost recovery should be reached by 2021[17] as a result of even year-to-year growth of registered prices starting from 2018. All in all, given these assumptions, we assume that prices of all energy commodities increase 10.12 percent each year in the period of 2018 to 2021.

Energy subsidy and devaluation reform scenario (ESR2, ESR22, ESR2a and ESR22a simulations): In addition to the described energy subsidy reform, this scenario simulates the 100 percent devaluation of the Egyptian pound in 2017. Accordingly, in addition to the growth of the registered prices of energy commodities, comparing to the base, this simulation assumes a 100 percent increase of all payment and receipts from the rest the world (export, import, remittances, foreign aid, etc.).

Energy subsidy, devaluation, and food subsidy reform scenario (ESR3, ESR23, ESR3a and ESR23a simulations): In addition to the two previous scenarios, this scenario assumes fixed increases of the subsidy rates of food commodities. In particular, it was assumed that all food subsidy rates (negative sales taxes of food commodities) are changing uniformly in line with the budgeted increase of the food subsidies program. Starting from 2013, subsidy rates for all food items are adjusted on average by 23.4 percent annually in the energy subsidy and devaluation reform scenarios (Appendix Table 2.2). Given average initial food subsidy rates of 8.8 percent on average, this implies that on average food prices increased by 2.1 percent less compared to what they would have increased without the additional food subsidies.

Energy subsidy, devaluation, food subsidy, and cash transfers reform scenario (ESR4, ESR24, ESR4a and ESR24a simulations): Finally, in addition to the previous scenarios, this set of simulations assumes the increase of cash transfers from the government to poor households based on information from the Ministry of Social Solidarity (Appendix Table 2.3).

4. IMPACTS OF REFORM PROGRAM ON THE ECONOMY AND HOUSEHOLDS

This section examines the effects of the energy price reform and devaluation of the Egyptian Pound based on the DCGE model. Because we are primarily interested in the impact on income distribution and household welfare, emphasis is given to how and why individual production sectors are affected differently and the impact channels that affect sectoral, functional, and household income distribution.

The increase in energy prices negatively impacts the macroeconomy in the short-run, but accelerates economic growth in the longer run. Table 4.1 contrasts the short and long-run magnitudes of changes in the major components of real GDP under alternative assumptions on the use of subsidy savings – subsidy savings are either completely used to finance additional investment (columns [2], [4], and [6]) or are used for a combination of investment and consumption spending (columns [3], [5], and [7]). Moreover, short-run results differentiate between the very short-run, i.e., individual years within the reform period 2014 to 2017 with downward rigid wages, and the three-year period 2014 to 2017 with flexible wages. The results reflect findings from other countries (and expectations) that higher energy prices reduce absorption and real GDP in the short-term (columns [2] and [3]), but have positive impacts (columns [4] to [5]) even if phasing-out of remaining energy subsidies further increases energy prices (columns [6] and [7]). The reason is that higher energy costs in combination with rigid wages lead to an increase in sectoral real producer wages in the short-run, which leads producers to reduce production and release workers. This increases unemployment and reduces real GDP and absorption by 2.8 and 2.3 percent, respectively. The

[17] We use the year 2021 as a target year for complete subsidies abolishment based on the most recent comments of the Electricity Minister of Egypt Mohamed Shaker regarding the phasing out of electricity subsidies. Source: Reuters

reduction in production and employment is most pronounced in energy-intensive sectors with a high share of hired labor inputs. These indirect wage and employment effects are less pronounced in the longer run, when flexible wages lead to a reallocation of factors between sectors. Higher investments and the reallocation of factors to less energy-intensive sectors following the phasing-out of remaining energy and electricity subsidies over the period 2018 to 2021 will increase both real GDP and total absorption. As shown in columns [6] and [7] of Table 4.1, real GDP is estimated to increase between 0.6 and 1.8 percent and absorption between 1.0 and 2.1 percent, depending on the way savings from energy subsidies are used.

Table 4.1: Short-term and long-term macroeconomic impacts of energy price reforms under alternative spending options of subsidy savings, percentage change from BASE

	Base year (2012)	Short-term (2014-17) Fixed wages		Short-term (2014-17) Flexible wages		Long-term (2014-25) Flexible wages	
	GDP shares	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Absorption	110.5	-2.3	-2.3	0.4	0.4	2.1	1.0
Private consumption	81.1	-4.6	-3.8	-1.4	-1.9	-2.4	-6.5
Fixed investment	14.6	8.9	2.9	11.2	4.1	29.6	14.9
Government consumption	12.1	0.0	1.3	0.0	11.1	0.0	36.2
Exports	18.5	-2.2	-2.8	0.6	-0.7	-0.2	-4.9
Imports	-29.0	-1.5	-1.8	0.4	-0.5	-0.1	-3.3
GDP at market prices	100.0	-2.5	-2.6	0.5	0.4	2.3	1.1
Net indirect taxes	-4.0	-11.5	-12.3	-9.4	-11.0	-12.3	-16.1
GDP at factor cost	104.0	-2.8	-2.9	0.1	0.0	1.8	0.6

Source: Egypt DCGE model
Note: Absorption is total domestic demand, i.e., the sum of private and government consumption plus fixed investment and stock changes. The latter is not shown in Table 4.1. but makes up 2.7 percent of GDP at market prices in the base year 2012.

Higher energy prices lead to a redistribution from consumption towards investment. In the short-term, fixed investment is estimated to increase between 2.9 and 8.9 percent, while private consumption is estimated to fall by between 3.8 and 4.6 percent compared to the baseline scenario. The magnitude of these effects largely depends on how savings of subsidy payments are spent. If all savings go to investment spending, then the reduction of the government budget deficit leads to a significant increase in fixed investment of 8.9 percent in the short-term. Yet, if part of the savings is used for public consumption purposes, such as increases in public sector wages[18], the combination of consumption smoothing by households and increasing government consumption will lead to lower private and public savings. This, in turn, lowers investment and reduces private income and consumption in both short and long-term.

The extent to which subsidy savings are used for consumption or investment affects the foreign trade balance. Since investment demand[19] is import-intensive, any change in investment demand affects import demand and the trade balance. While import demand with the energy price reforms generally is shown to decline when all public savings from energy subsidy payments are used to

[18] As noted in the scenario descriptions, we assume that both total (private and public) consumption and investment shares of absorption are held constant.

[19] Beside construction services (65 percent of investment demand), manufactures of basic metals; fabricated metal products, except machinery and equipment; computer, electronic, and optical products; electrical equipment; and other machinery and equipment, which are all very import-intensive, are important investment goods.

finance investment expenditures (Table 4.1, columns [2], [4], and [6]), the decline in import demand is less than when the savings from subsidies are used for investment and consumption (columns [3], [5], and [7]). When the subsidy savings are used only for investment, imports are reduced by 1.5 and 0.1 percent in the short-run and the long-run, respectively, compared to a reduction by 1.8 and 3.3 percent if the savings from subsidies are used for both investment and consumption.

Table 4.2: Short-term and long-term sectoral impacts of energy price reforms under alternative spending options of subsidy savings, percentage change from BASE

	Base year (2012)	Short-term (2014-17) Fixed wages		Short-term (2014-17) Flexible wages		Long-term (2014-25) Flexible wages	
	GDP shares	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
GDP	100.0	-2.8	-2.9	0.1	0.0	1.8	0.6
Energy	17.4	-1.9	-1.9	-1.2	-1.4	-2.7	-3.5
Non-energy	82.6	-3.0	-3.1	0.4	0.3	2.7	1.4
Agriculture	9.9	-3.1	-2.9	0.0	-0.4	1.7	-1.6
Industry	38.0	-1.6	-2.4	0.3	-1.0	2.5	-1.6
Mining	13.5	0.0	0.1	0.1	0.2	2.8	3.5
Manufacturing	17.1	-5.3	-5.6	-2.0	-3.3	-5.6	-10.9
Agro-processing	2.2	-2.8	-2.6	-0.4	-1.1	0.3	-2.9
Other manufacturing	14.9	-5.7	-6.0	-2.3	-3.6	-6.4	-12.0
Utilities	1.3	-6.5	-6.3	-3.4	-3.4	-7.4	-7.8
Construction	6.1	6.2	1.6	8.2	2.8	25.2	12.3
Services	52.1	-3.6	-3.2	0.0	0.8	1.3	2.4
Transport	5.8	-9.3	-9.4	-5.1	-6.4	-25.2	-28.6
Other services	46.3	-2.9	-2.5	0.6	1.7	4.8	6.5

Source: Egypt DCGE model

Economic sectors are affected differently from energy subsidy reform in the short-term, ranging from growth acceleration in mining and construction to reduction in output for the energy sector and all other sectors (Table 4.2). Mining and construction are the only sectors that are projected to benefit from the reduction of energy subsidies both in the short and long-run. Real GDP generation in mining (including the energy sectors crude oil and natural gas production) increases slightly in the short-run with increasing labor market flexibility (columns [4] and [5] versus columns [6] and [7]) and strongly in the long-run, with the complete phasing-out of energy subsidies. The effect can be traced back to the (exogenous) investments in the crude oil and natural gas sectors, which dominate the mining sector. Income generation in the construction sector increases between 1.6 to 8.2 percent in the short-run, depending on labor market flexibility and the use of subsidy savings. The benefits are solely attributable to higher prices and increasing investment demand, i.e., the use of subsidy savings, which overcompensate the losses resulting from higher intermediate input costs, i.e., higher energy prices. Moreover, construction is almost a non-tradable good – with low import and export shares of 0.9 and 1.7 (Table 2.3) – and therefore not directly affected by world market price changes. Most importantly, according to the SAM for Egypt, construction services are strongly related to investments (78 percent of total supply) and as intermediate input in other sectors' production (14 percent of total supply). All other sectors experience real income losses as a result of increasing production costs. The changes in real income are most pronounced in other manufacturing, particularly textiles, machinery, and vehicles; utilities, including electricity and water; and the transport sector, all of which heavily depend on energy inputs (Table 2.2).

In the longer-term, more economic sectors are expected to benefit from energy subsidy reform, including agriculture, agro-processing, and non-transport services. In the medium and long-term, when wages are flexible and hired labor is mobile across sectors, fully employed labor together with higher investment and changes in sectoral real producer wages lead to an increase in both real GDP and absorption or overall welfare, reallocation of income from energy to non-energy sectors, and reallocation from energy-intensive to non-energy-intensive sectors (Table 4.1). These sectors include agriculture, agro-processing, and non-transport services.

Yet, despite these overall gains and positive impacts on several sectors, the impact on household consumption in the short and longer-term is projected to be negative (Table 4.1). Increasing energy prices and the accompanying reduction of energy subsidies improve economic growth prospects and absorption possibilities over time, but lead to lower private (household) consumption by between 1.4 and 6.5 percent. The total reduction of private consumption is largest if all energy and electricity subsidies are phased out and a large part of public sector savings of energy subsidies are used to finance public sector consumption, which essentially entails remuneration of public sector employees. If we assume that absorption shares for private and government consumption (and investment) are kept constant, this implies that government consumption of non-tradable public goods would increase by more than 35 percent over the period 2014 to 2025. In this case, the energy subsidy reform not only increases energy prices and intermediate input cost, but also the cost of public services, thereby hampering growth (0.6 percent rather than 1.8 percent) and income generation in the private sector. In addition, the factor market effects will lead to a redistribution of income and changes in consumer prices, which affect individual household's welfare differently.[20] As shown in Table 4.3, almost all households experience welfare losses, both in the short-term and the long-term.

The exception is urban high-income households, whose real consumption increases slightly by 1.1 percent in the long-run, when all subsidies are phased out and all savings of energy subsidy payments are used to finance additional investment. This positive effect is caused by the strong expansion of the construction sector, that heavily relies on capital, which is one of the main income sources of urban high-income households. All other urban households experience welfare losses ranging from 1.5 percent for medium-income households in the short-run and with flexible labor markets (column [4]) to 16.0 percent for poor households in the long run, when subsidy savings are used for investment and consumption (column [7]). Rural households are on average more strongly negatively affected by higher energy prices than urban households, despite their lower energy spending share. In addition, rural poor households and urban high-income households benefit most from labor market flexibility in the short-run.

[20] We measure household welfare by the so-called Hicksian equivalent variation, which takes into account price changes.

Table 4.3: Short-term and long-term welfare impacts of energy price reforms under alternative spending options, percentage change from BASE

	Base year (2012)	Short-term (2014-17) Fixed wages		Short-term (2014-17) Flexible wages		Long-term (2014-25) Flexible wages	
	Consump-tion shares	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
All households	100.0	-5.3	-4.5	-2.1	-2.6	-5.6	-9.2
Rural households	49.4	-5.6	-4.9	-3.0	-3.2	-8.5	-11.0
Rural poor households	12.1	-3.0	-3.2	-1.4	-2.0	-6.4	-8.5
Rural middle-income households	18.9	-4.8	-4.0	-2.8	-2.6	-8.1	-9.5
Rural high-income households	18.4	-8.0	-6.7	-4.3	-4.5	-10.2	-14.0
Urban households	50.6	-5.0	-4.2	-1.2	-1.9	-2.5	-7.2
Urban poor households	9.8	-6.1	-6.7	-3.1	-4.8	-10.7	-16.0
Urban middle-income households	17.3	-4.6	-3.6	-1.5	-1.6	-2.6	-5.9
Urban high-income households	23.5	-4.8	-3.5	-0.2	-1.0	1.1	-4.5

Source: Egypt DCGE model

Energy subsidy reform has a stronger impact on households than does the currency devaluation over time. The devaluation adds to the negative impact from energy subsidies on household welfare, lowering consumption of all households both in the short and the long-run (Table 4.4). Yet, the negative quantitative impact of devaluation seems to be limited – welfare losses increase by less than one percentage point if energy subsidy cuts are combined with a 100 percent devaluation of the EGP, as happened at the end of 2016.[21] The reason is that devaluation affects both the demand and the supply side, and household welfare is affected both via increasing prices for imports and via increasing prices for import substitutes and export goods. At the macroeconomic level, the overall import-demand share of 17.5 percent and the overall export-supply share of 9.7 percent would suggest a sizable negative impact of a 100 percent devaluation. Yet, several sectors are both import-oriented, with high shares of imports in domestic absorption of the respective good, and export-oriented, with high shares of exports of domestic production (Table 2.3). These sectors benefit twice from devaluation: import substitution by consumers in response to higher prices of imports drives up prices for domestically-produced substitutes. At the same time, export transformation by domestic producers in response to higher export prices reduces domestic supply, which enforces upward pressure on domestic prices.

In fact, results suggest that **the currency devaluation only modestly adds to the negative impacts on households**, especially in the longer-run. The reason is that devaluation, besides increasing the cost of living through higher import prices, also leads to import substitution and export expansion on the supply side. In the short-run, higher producer prices lead to lower increases in sectoral real producer wages and lower unemployment. In addition, devaluation increases the local currency equivalent of remittances from abroad, which benefits all households, particularly rural households (Table 2.4). Together, energy subsidy reform and devaluation reduce household welfare by between 5.3 and 6.0 percent if subsidy savings are exclusively invested or shared by consumption and

[21] As the model is run annually and the devaluation happened at the end of 2016, we introduce the changes in world market prices in 2017.

investment spending, respectively. In any case, rural high-income households and urban poor households experience the highest welfare losses. Food subsidies benefit all rural households and poor urban households at the expense of medium and high-income urban households, while the design of the cash transfer program leads to a redistribution of welfare from richer urban and rural households to poor urban and rural households, with the main beneficiaries being poor rural households. This holds true in both the short and long-run (Tables 4.4 and 4.5).

Within all household groups, **high-income households in rural areas and poor households in urban areas tend to be the most heavily affected by the combination of energy subsidy cuts and currency devaluation**. The notable beneficiary group is urban high-income households, which lose only slightly in the medium-term and even benefit slightly from energy price reform in the long-term, if public savings from the phasing-out of energy subsidies leads to a significant increase of investment (Table 4.1, column [7]) and a significant expansion of construction of 25 percent (Table 4.2). Earning a large share of their income from capital and mixed income, urban high-income households benefit from the expansion of family labor and capital-intensive construction.

The increase in food subsidies and the introduction of the cash transfer program (Takaful and Kamara) helps mitigate the negative impact on the poor. Tables 4.4 and 4.5 show first the short-run and then the long-run impacts on household welfare of energy subsidy cuts (column [2] and [3]), with devaluation (column [4] and [5]), with food subsidies (column [6] and [7]), and finally the total reform package, including cash transfers to poor rural and urban households (column [8] and [9]). Our estimates suggest that without the increase in food subsidies, welfare losses would have been between 7.5 and 8.7 percent for urban poor households and about 4.0 percent for the rural poor. Without the cash transfer program, welfare losses would have been between 7.1 and 7.5 percent for the urban poor and about 3.5 percent for rural poor. The two measures combined increased poor households' welfare by about 2 percentage points in rural areas, but only by 0.3 percent in urban areas. While both measures lower consumption losses of poor households, cash transfers tend to be more effective, as they are targeted at the lowest two rural and urban income quintiles, while the labor market effects of food subsidies also benefit rural middle-income households in the third and fourth rural income quintiles.

Table 4.4: Short-term welfare impacts of the reform package, percentage change from BASE

	Base year (2012)	Energy subsidy reform		Energy subsidy and devaluation reform		Energy subsidy, food subsidy, and devaluation reform		Energy subsidy, food subsidy, devaluation, and cash transfer reform	
	Consumption shares	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
All households	100.0	-5.3	-4.5	-6.0	-5.3	-5.9	-5.2	-5.9	-5.2
Rural households	49.4	-5.6	-4.9	-6.3	-5.6	-6.1	-5.4	-5.9	-5.2
Rural poor households	12.1	-3.0	-3.2	-3.9	-4.0	-3.5	-3.6	-2.1	-2.2
Rural middle-income households	18.9	-4.8	-4.0	-5.5	-4.8	-5.3	-4.6	-5.5	-4.8
Rural high-income households	18.4	-8.0	-6.7	-8.7	-7.5	-8.4	-7.2	-8.6	-7.5
Urban households	50.6	-5.0	-4.2	-5.7	-4.9	-5.8	-5.0	-5.9	-5.2
Urban poor households	9.8	-6.1	-6.7	-7.2	-7.6	-7.1	-7.5	-6.9	-7.3
Urban middle-income households	17.3	-4.6	-3.6	-5.3	-4.3	-5.4	-4.4	-5.7	-4.7
Urban high-income households	23.5	-4.8	-3.5	-5.3	-4.2	-5.5	-4.4	-5.8	-4.6

Source: Egypt DCGE model

Table 4.5: Long-term welfare impacts of the reform package, percentage change from BASE

	Base year (2012)	Energy subsidy reform		Energy subsidy and devaluation reform		Energy subsidy, food subsidy, and devaluation reform		Energy subsidy, food subsidy, devaluation, and cash transfer reform	
	Consumption shares	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
All households	100.0	-2.1	-2.6	-2.8	-3.3	-2.8	-3.3	-2.8	-3.3
Rural households	49.4	-3.0	-3.2	-3.7	-3.9	-3.5	-3.7	-3.3	-3.5
Rural poor households	12.1	-1.4	-2.0	-2.3	-2.7	-2.0	-2.4	-0.5	-0.9
Rural middle-income households	18.9	-2.8	-2.6	-3.5	-3.3	-3.3	-3.1	-3.5	-3.4
Rural high-income households	18.4	-4.3	-4.5	-4.9	-5.3	-4.7	-5.0	-4.9	-5.3
Urban households	50.6	-1.2	-1.9	-1.8	-2.6	-2.0	-2.8	-2.2	-3.0
Urban poor households	9.8	-3.1	-4.8	-4.1	-5.6	-4.1	-5.6	-3.9	-5.3
Urban middle-income households	17.3	-1.5	-1.6	-2.1	-2.3	-2.3	-2.5	-2.5	-2.8
Urban high-income households	23.5	-0.2	-1.0	-0.6	-1.6	-1.0	-1.9	-1.2	-2.1

Source: Egypt DCGE model

Table 4.6: Short-term and long-term welfare impacts of energy price reforms, devaluation, food subsidies and cash transfers under alternative spending options, percentage change from BASE)

	Short-term (2014-17) Fixed wages		Short-term (2014-17) Flexible wages		Long-term (2014-25) Flexible wages	
	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption	Savings finance investment	Savings finance investment & con-sumption
	[1]	[2]	[3]	[4]	[5]	[6]
All households	-5.9	-5.2	-2.8	-3.3	-7.0	-10.8
Rural households	-5.9	-5.2	-3.3	-3.5	-9.2	-12.0
Rural poor households	-2.1	-2.2	-0.5	-0.9	-4.4	-6.4
Rural households, lowest quintile	-0.1	0.1	1.0	0.9	-0.7	-2.0
Rural households, 2nd quintile	-3.5	-3.7	-1.6	-2.2	-7.1	-9.5
Rural middle-income households	-5.5	-4.8	-3.5	-3.4	-9.8	-11.5
Rural households, 3rd quintile	-6.1	-5.7	-4.2	-4.3	-11.8	-13.6
Rural households, 4th quintile	-5.0	-4.1	-3.0	-2.6	-8.1	-9.6
Rural high-income households	-8.6	-7.5	-4.9	-5.3	-11.7	-15.8
Urban households	-5.9	-5.2	-2.2	-3.0	-4.7	-9.6
Urban poor households	-6.9	-7.3	-3.9	-5.3	-12.6	-17.3
Urban households, lowest quintile	-5.1	-5.4	-2.6	-3.8	-9.4	-13.6
Urban households, 2nd quintile	-8.0	-8.5	-4.8	-6.3	-14.7	-19.8
Urban middle-income households	-5.7	-4.7	-2.5	-2.8	-4.9	-8.6
Urban households, 3rd quintile	-4.4	-3.8	-1.4	-1.9	-3.0	-6.7
Urban households, 4th quintile	-6.5	-5.4	-3.4	-3.5	-6.3	-9.9
Urban high-income households	-5.8	-4.6	-1.2	-2.1	-1.2	-7.1

Source: Egypt DCGE model

However, **there is room for further expanding the social safety net, as not all poor households are able to maintain their pre-reform consumption levels**, especially when energy subsidies are phased out. This effect is expected, as the Takaful and Karama program currently does not yet cover all poor households and the food subsidy system does not reach all poor households. The simulation results suggest that with the help of food subsidies and Takaful and Karama, only the poorest rural households – the lowest rural income quintile – are able to keep their consumption level constant despite higher energy prices and devaluation in the short-run. Moreover, the poorest rural households tend to slightly benefit from the reform package in the long-run, as the reallocation of factors from energy-intensive to non-energy-intensive sectors and from less tradable towards more tradable sectors leads to an increase in the remuneration of self-employed and family labor (Table 4.6, columns [1] to [4]). Finally, the results suggest that a total phasing-out of energy-subsidies over the period 2018 to 2021 requires additional support to protect the poorest in Egypt from the negative impacts of the energy reforms.

5. CONCLUSIONS AND POLICY RECOMMENDATIONS

There are only a few countries in the world that have implemented a comprehensive economic reform package that is comparable in terms of time and scope to Egypt. A main lesson from countries that did implement such reforms is that protecting the poor from the negative impacts of energy subsidy reform is critical for success. Early evidence from Egypt shows that the economic reform package is achieving its intended economic outcomes, including improvements in the current account balance and budget deficit and an acceleration of economic growth. The findings of this paper suggest that the positive macro-economic impacts are likely to increase over time if the reform program is sustained. In addition, the model results suggest that the increase in food subsidies and the introduction of the Takaful and Karama program helped in mitigating the negative impacts of the reform program on households, especially for the poor. Several key messages emerge from this study.

The implementation of the economic reform package should be sustained. Early numbers from the Egyptian Central Bank, the Ministry of Finance, and CAPMAS suggest that key macro-economic indicators are improving. As such, macroeconomic considerations, such as the reduction of the public-sector budget deficit, reduction of the balance of payment and current account deficit, and savings for investment mobilization, all call for the continued phasing-out of energy subsidies. However, our analysis suggests that it will take time for the full positive impact of reform to materialize, especially for certain sectors and for households. In order to give economic sectors and households time to adjust to higher energy prices, especially in combination with the effects of devaluation, our results suggest that continuing a gradual approach to phasing out energy subsidies is preferable to a quick phasing out.

However, there are several measures that would likely accelerate the positive impacts of reform. The literature suggests that providing a more enabling business environment for enterprises, entrepreneurs, and workers is essential for raising productivity and competitiveness (WEF 2015). The new investment law enacted by the Parliament in 2017 is a first step in this direction. In addition, our findings suggest that measures that increase labor market flexibility, such as labor law reforms and technical and vocational training, are critical to help workers to move between sectors, especially for unskilled labor. Regarding the longer-term impact of the currency devaluation, it is important that the real devaluation is not undermined by sharply increasing wages in both the public and private sectors.

Social protection measures should be continued and scaled up in parallel to phasing out energy subsidies. Our findings show that increasing food subsidies and the introduction of Takaful and Karama has protected the people from the short-term negative impact of the reform program. But, fully phasing-out energy subsidies over coming years will require additional support for poor households, especially the urban poor. While it is beyond the scope of this paper to enter the debate about whether food or cash transfers are preferable, results from this study confirm earlier findings that food subsidies are effective in reducing the negative welfare effects of the reforms on rural and urban poor households, but that they are not well targeted. Targeted cash transfers to the poorest rural and urban households are more effective and efficient in protecting the poor.

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APPENDICES

Appendix 1: Social Accounting Matrix for Egypt, 2012/13

Appendix Table 1.1. Macro Social Accounting Matrix, Egypt, 2012/13, billions EGP

				Factors			Institutions					
Revenues / Expenditures	**Activities**	**Commo-dities**	**Transac-tion costs**	**Labor**	**Capital**	**Land**	**Enter-prises**	**House-holds**	**Govern-ment**	**Capital account**	**Rest of the world**	**Total**
Activities		3,032										3,032
Commodities	1,212		276					1,418	211	303	323	3,743
Transaction costs		276										276
Labor	987											987
Capital	811											811
Land	22											22
Enterprises				399	645			21	96		-36	1,125
Households				588	166	22	874		5		116	1,770
Government		-71					112	39			1	82
Capital account							139	292	-231	47	102	350
Rest of the world		506										506
Total	3,032	3,743	276	987	811	22	1,125	1,770	82	350	506	

Source: Computed from CAPMAS SAM 2012/13

Appendix 2: Scenario inputs and assumptions

Appendix Table 2.1. Year-to-year growth rates of the registered prices of fuel commodities, 2014 to 2017, percent

Commodity	2014	2015	2016	2017
Natural gas[22]	111.0	8.2	32.0	72.4
LPG	-	-	87.5	100.0
Gasoline 80	77.8	-	46.9	55.3
Gasoline 92	40.5	-	34.6	42.9
Gasoline 95	6.8	-	4.0	-
Kerosene	63.6	-	30.6	55.3
Diesel	63.6	-	30.6	55.3
Mazut[23]	26.3	-	8.6	40.0
Electricity[24]	26.0	17.3	30.0	40.0

Source: Own estimations based on publicly available information.

Appendix Table 2.2. Subsidy rates of selected food commodities, 2014 to 2017, percent

	Wheat	Sugar	Cooking oil	Flour	Rice	Seeds, etc.	Fruits & nuts	Vege-tables
2014	-60.4	-58.7	-30.8	-16.8	-13.6	-8.2	-2.4	-1.5
2015	-65.5	-63.7	-33.4	-18.2	-14.8	-8.9	-2.6	-1.6
2016	-63.0	-61.3	-32.1	-17.5	-14.2	-8.5	-2.5	-1.5
2017	-96.7	-94.1	-49.3	-26.8	-21.8	-13.1	-3.9	-2.4

Source: Own estimations based on publicly available information. .
Note: Since subsidy rates are modeled as negative indirect tax rates, this implies new (negative) indirect tax rates. As such the same positive numbers shown in Appendix Table 2.2 are introduced as negative values in the model.

Appendix Table 2.3. Year-to-year growth rates of budgeted cash transfers program, 2015 to 2017, percent

	2015	2016	2017
Poor urban households	151	85	70
Poor rural households	934	127	85

Source: Own estimations based on publicly available information

[22] The price changes of natural gas were calculated based on a weighted average of registered prices for residential and non- residential use. Weights were obtained from the webpage of the International Energy Agency. Prices for residential and non- residential categories were calculated as simple averages of registered prices for different sub-categories of users.

[23] Price changes for mazut (heavy fuel oil) for the years 2014 to 2016 were calculated based on a simple average of registered price for different categories of users. For the price change in 2017, information from the IMF country report (2017), pp.70-71, was used.

[24] The price changes of electricity in the years 2014 and 2015 were calculated based on a weighted average of the registered prices for residential and non- residential use. Weights were obtained from the webpage of the International Energy Agency. Prices for residential and non- residential categories in turn were calculated as simple averages of registered prices for different sub-categories of users.

For the price changes in 2016/17, information from the IMF country report (2017), pp.70-71, was used.

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