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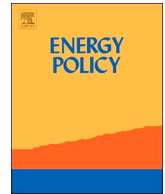
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Energy subsidy reform for growth and equity in Egypt: The approach matters

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ABSTRACT

Phasing out energy subsidies is high on the agenda of policymakers in several Middle Eastern and North African countries. The impact of such reform can vary widely depending on the country and policy. This paper contributes to the existing literature by examining the phasing out of energy subsidies in Egypt under alternative economic scenarios. In particular, we consider Egypt's short- and long-term economic adjustment under different assumptions on labor market flexibility, spending options of subsidy savings, and alternative social protection measures. Results from economy-wide model simulations suggest that energy subsidy cuts may hamper economic growth in the short term, but depending on the policy measure, will improve growth perspectives and household welfare in the longer term. Yet, findings also point to likely adverse impacts of the reform on household consumption in the short and longer run. To counteract such negative impacts, targeted social protection measures should be continued and scaled up in parallel with the phasing out of energy subsidies.

1. Introduction

Energy subsidies remain in place in several low- and middle-income countries. The declared objectives of this type of government intervention are often related to wealth redistribution and the protection of domestic consumers from fluctuating energy prices in international markets (IMF, 2017). However, these energy subsidies often come at the cost of several side effects. In particular, energy subsidies in developing countries frequently contribute to large fiscal deficits and can potentially divert resources away from more growth-promoting and poverty-reducing expenditure categories, such as infrastructure, education, and health. Moreover, for energy-importing countries, the existence of subsidies and associated incentives for overconsumption of energy also imply deterioration of the balance of payments. Furthermore, a high level of energy subsidization is also expected to create an economic bias in favor of capital- and energy-intensive industries, such as petrochemicals, steel, cement, fertilizers, aluminum, and copper. The reallocation of resources toward these sectors naturally comes at the expense of more labor-intensive and thus job-creating industries (IMF, 2015), including renewable energy sectors, such as biofuels (Clancy, 2008). In addition, energy subsidies often hinder economic diversification and reduce incentives for the adoption of energy-efficient innovative technologies. Finally, subsidized energy prices often disproportionately benefit rich households. This happens because of their

relatively higher energy consumption (e.g., through car ownership) and better access to subsidized products (e.g., better connectivity to electricity grids) (IMF, 2017). For example, IMF (2017) estimates suggest that the poorest quintile in Egypt, Jordan, Mauritania, Morocco, and Yemen receive between only 1 and 7 percent of total diesel subsidies, which is considerably lower than the 42 to 77 percent of receipts by the richest quintile (El-Katiri and Fattouh, 2015).

Given these considerations, the number of countries that initiated energy subsidy reforms has increased significantly in recent years. In particular, these reforms are currently being implemented in several Middle Eastern and North African (MENA) countries, such as Egypt, Jordan, and Sudan. Accordingly, the process of economic and social adjustment associated with the energy subsidy reforms is of particular interest to both policymakers and researchers concerned with socio-economic development in these countries.

Research and empirical evidence suggests that the elimination of energy subsidies can hinder economic growth during the adjustment process as enterprises face higher costs for energy inputs (Verne, 2016). Moreover, the increase of energy prices often negatively affects real household incomes—first, directly, through higher prices of consumed energy commodities and, second, indirectly, through higher prices of other goods and services caused by the increased costs of intermediate inputs, such as transportation and trade. Coady et al. (2015) estimate that an increase of US\$0.25 per liter of fuel may result in a 5.5 percent

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decline in real household income (average across the sample of 32 countries). This impact ranges from 3.5 percent in South and Central America to 7.0 percent in the MENA region, where retail prices are still comparatively low.

A number of studies use computable general equilibrium (CGE) models to highlight the transmission channels through which the removal of energy subsidies affects the domestic economy. Findings for Malaysia by Solaymani and Kari (2014) show that the transport sector is significantly influenced by an increase in production costs due to an increase in the prices of intermediate inputs. Other simulation results by Li et al. (2017) suggest that Malaysia completely remove all fuel subsidies and use the saved funding to cut the budget deficit or spend on education, health, and other service sectors. It is also necessary to set a compensation scheme to minimize public resistance and make sure such a scheme is affordable. Gelan (2018) examined the economic and environmental impacts of reducing electricity subsidies in Kuwait using a CGE model. The simulation experiments showed trade-offs in aggregate economic and environmental effects. Compensating users for losses in revenues or welfare seem to reverse the adverse economic effects. Energy subsidy reforms would need to be designed taking into account conflicting effects. Finally, Dennis (2016) uses a global CGE model to investigate the global welfare effects of fossil fuel subsidy cuts. The simulation results show that the welfare impact of the removal of fossil fuel subsidies are positive for governments. However, the impact on private households is rather mixed. Where the welfare impact is negative, governments can preserve household welfare. This can be done by compensating households while still retaining some fiscal savings.

Several studies concentrated particularly on Egypt, investigating the impact of its 2014 energy subsidy reform (Griffin et al., 2016; Banerjee et al., 2017). Consistent with findings from other countries, these studies suggest that the reform that took place in 2014 has resulted in a modest decline in real household consumption and a slight increase in poverty levels in the short term. Results also suggest that the reform may lead to structural economic adjustment and boost economic growth in the longer run.

This paper builds on these previous efforts and investigates Egypt's economic adjustment associated with a recently announced plan for a complete phaseout of energy subsidies in combination with a new social protection program for the most vulnerable households.

The remainder of this paper is structured as follows: Section 2 presents the country-specific background for Egypt. Section 3 presents the economy-wide model and describes considered scenarios. Section 4 discusses the results, and Section 5 concludes.

2. Energy subsidies and economic structure of Egypt

The first partial attempts to reduce the level of energy subsidization in Egypt were implemented in 2012 and 2013. In particular, the Government of Egypt (GOE) increased registered prices of liquefied petroleum gas (LPG), gasoline, natural gas, and diesel.¹ Nevertheless, the subsidy-to-cost ratio remained high, particularly for LPG (around 81 percent), followed by diesel (about 58 percent) and gasoline (44 percent) (MoF, 2012). All in all, by 2013 fuel and electricity subsidies together accounted for 21.9 percent of total government expenditure (Fig. 1) and reached 6.0 percent of GDP, representing one of the major sources of macroeconomic instability.

In 2014, the GOE initiated a comprehensive economic reform program to restore macroeconomic stability and promote inclusive growth. As one of its key elements, the program includes energy subsidy reform plus associated measures to counteract the expected negative effects for the most vulnerable households. At its core, the subsidy reform has the

objective of reaching a target of 100 percent of the price-to-cost ratio of the energy commodities via the gradual increase of registered prices. The most significant increase in prices took place during the period of 2014–2017 (Table 1).

Following these measures, the fiscal deficit for the fiscal year (FY) 2016/17 was reduced to 10.9 percent of GDP (MoF, 2017b), and the savings from the energy subsidies were largely redistributed toward investment spending (Fig. 1). At the same time, the GOE concentrated its efforts on protecting households from the impact of energy subsidy reform by increasing the amount of food subsidies and introducing a cash transfers programs.

Despite the significant increase in prices, energy remains heavily subsidized. This is largely a consequence of the floatation and following devaluation of the Egyptian pound in November 2016,² which increased the cost of imported commodities (Fig. 1). Therefore, after several years of decline, the share of energy subsidies in government expenditures is projected to increase from 6.4 percent to 11.6 percent between 2016/17 and 2017/18 (Fig. 2).

In order to comprehensively analyze the economic adjustment associated with the reform, we first consider the most important structural features of the Egyptian economy (Tables 2 and 3).

The structure of output (Table 2, column 2) reveals the typical composition of production of a middle-income, semi-industrialized country, where agriculture still constitutes a relatively large share of the economy. The energy sector makes up 20 percent of total production, with crude oil, natural gas, petroleum products and electricity contributing 5.6, 3.1, 9.0, and 2.9 percent of total output, respectively. Energy inputs in turn make up a large share of total production costs in natural gas, the manufacturing of textiles and nonmetallic mineral products, electricity production, and the transport sector.³ This implies that the reduction of energy subsidies and the related increase in energy prices will increase intermediate input costs in these sectors, thereby hampering their competitiveness both in international and domestic markets.

The importance of primary production factors for each sector is presented in columns 6–9 of Table 2. The intensity of factor use has important distributional implications. Self-employed and family workers are not used in nonagricultural primary sectors, petrol refining and chemicals, or utilities, while land is only used in agriculture. Moreover, the supply of these factors is assumed to be sector-specific both in the short and long term. As a result, self-employed and family labor's remuneration is determined by demand, and if it slackens, lower prices are directly transmitted into the lower incomes of these households.

The last column of Table 2 shows the supply elasticities that determine the sectoral results of the reform simulations by the model. Because production technology for sectoral value-added is modeled by a two-level constant elasticity of substitution (CES) production function, the shares observed in the initial data together with the factor substitution elasticities provide 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 (see Table 2, columns 10 and 6).

The welfare of households is affected on both the expenditure and income sides. Accordingly, the main transmission channels are changes of factor remuneration on the income side and changes of consumer prices on the expenditure side. Table 3 summarizes income and expenditure patterns for urban and rural households.

² The Central Bank of Egypt floated the Egyptian pound in November 2016, and the exchange rate fell sharply from US\$1.0 = EGP 8.8 prior to the floatation to EGP 17.7 in early 2018.

³ In these sectors, energy costs make up about 15 percent of costs in the manufacturing of textiles and 82 percent in electricity generation and distribution.

¹ A 220 percent increase in the price of LPG, full cost recovery prices for gasoline 95, and small increases in the prices of natural gas, diesel, and gasoline 80 and 92 (IISD, 2014).

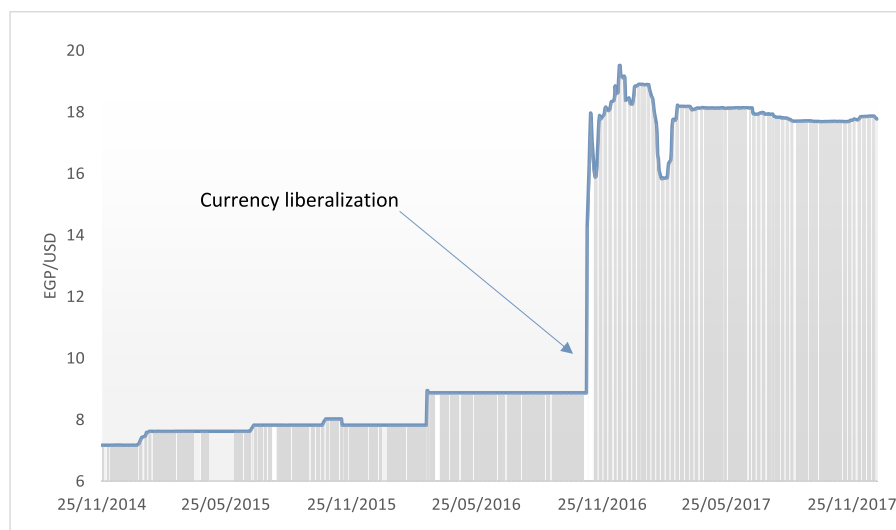


Fig. 1. Exchange rate movements.

Source: Central Bank of Egypt, various issues.

Table 1

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

Source: Own estimations based on publicly available information.

Commodity	2014	2015	2016	2017
Natural gas ^a	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 ^b	26.3	–	8.6	40.0
Electricity ^c	26.0	17.3	30.0	40.0

Notes: Prices of the energy commodities (period of 2014–2017) were calculated based on information from different sources that included several decrees of the Ministry of Petroleum (MoP, 2014), reports of the Ministry of Electricity (MoEE, 2015; MoEE, 2016), IMF reports, and several issues of *Egypt Oil & Gas news-letters*.

^a The price changes of natural gas were calculated based on a weighted average of registered prices for residential and nonresidential use. Weights were obtained from the webpage of the International Energy Agency (IEA, 2018). Prices for residential and nonresidential categories were calculated as simple averages of registered prices for different subcategories of users.

^b Price changes for mazut (heavy fuel oil) for the years 2014–2016 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, 70–71) was used.

^c 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 (IEA, 2018). Prices for residential and nonresidential categories in turn were calculated as simple averages of registered prices for different subcategories of users.

Poor households, which make up 40 percent of the total population,⁴ account for only 20 percent of total 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, respectively. The sources of household income 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 an important 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. 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 areas.

3. An energy-focused, dynamic, computable general equilibrium model for Egypt

The empirical analysis is based on an energy-focused, dynamic, computable general equilibrium (DCGE) model that has been calibrated to a slightly modified version of an Egyptian social accounting matrix (SAM) for fiscal year 2012/13, constructed by the Central Agency for Public Mobilization and Statistics (CAPMAS, 2016). The SAM has 38 production activities, 59 commodities, 11 factors of production, 10 household types (rural and urban by expenditure quintile), various tax accounts (including sales subsidies), a savings/investment account, an enterprise account, and the account that represents the interaction of Egypt with rest of the world. Because the focus of this paper is on energy subsidies, the multisectoral DCGE model has a special emphasis on energy-related activities and their linkages to other production sectors. A sectoral distinction is made within the industry sector between energy-producing subsectors (crude oil, natural gas, petrol, and electricity), energy-dependent subsectors (textiles, nonmetallic mineral products, electricity, and water collection, treatment, and supply) and other industrial subsectors (see, e.g., Table 2). Finally, there are eleven service sectors, two of which are highly dependent on energy intermediate inputs (wholesale and retail trade, and transport). An aggregate version of the SAM can be found in Appendix.⁵

⁵ It should be noted that the constructed SAM might not reflect the true financial costs of energy subsidies. This is because 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 inflation 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 is focused on the real economy adjustments and households rather than on fiscal developments.

⁴ According to a US\$2 per day poverty line.

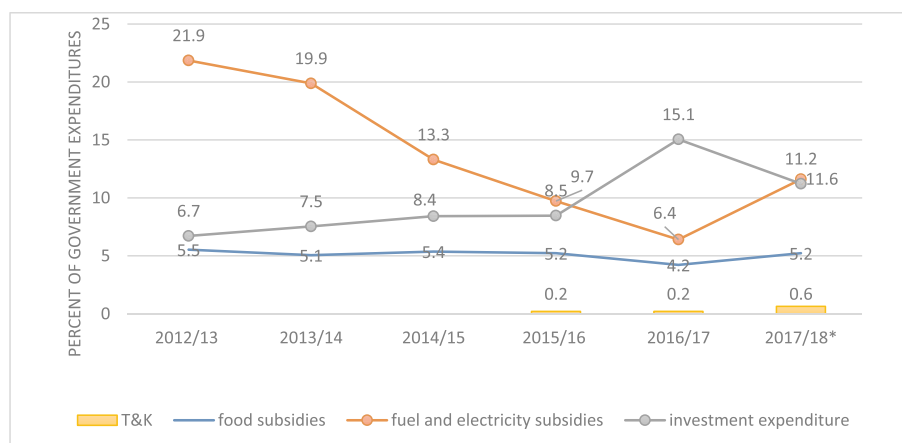


Fig. 2. Energy subsidies, food subsidies, and investment as a percentage of total government expenditures.

Source: MoF, 2017a,b. Notes: * = Projected. T&K = Takaful and Karama. Egypt has been providing cash to poor households through its first conditional cash transfer program, Takaful and Karama, a social protection program run by the Ministry of Social Solidarity (MoSS), since March 2015. Takaful (“solidarity”) supports poor families with children under 18, while Karama (“dignity”) supports the elderly poor and people living with disabilities. The cash transfer program has enrolled 2.25 million families across all of Egypt’s governorates (Breisinger et al., 2018).

Table 2

Structure of supply.

Source: CAPMAS, 2016.

	Initial output 2012/13, billions EGP	Output share, percent	Per output- unit total intermediate input share, percent	Per total intermediate input unit energy share, percent	Per output unit energy share, percent	Per value- added unit hired labor share, percent	Per value- added unit family labor share, percent	Per value- added unit capital share, percent	Per value- added unit land share, percent	Partial supply elasticity ϵ^S
	[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 Nonmetallic 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
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	

Table 3
Structure of household income and expenditures.
Source: CAPMAS, 2016.

	Household income (percentage share of total)							Total billions EGP	Household expenditures (percentage share of total)			
	Hired labor	Family labor	Capital	Land	Net transfers from				Energy	Nonenergy	Taxes	Savings
								Enterprises				
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
All households	18.55	15.05	9.46	1.28	48.77	0.28	6.61	1749.69	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 medium-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 medium-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

The DCGE model is based on this SAM, which represents the initial equilibrium position of the Egyptian economy in 2012/13 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. \(1982\)](#) and follows a standard specification as documented by [Diao and Thurlow \(2012\)](#). The CGE model is superior to a partial equilibrium model in three ways: First, it captures the macroeconomic repercussions of the energy reform that result from budget improvements and the spending of former subsidy payments. Second, it takes into account changes in intermediate input costs, which affect energy-intensive and energy-extensive sectors very differently, thereby leading to a reallocation of scarce resources. Finally, it affects households differently on the income earnings and income spending side, therefore having a strong impact on household welfare. While the core equations of the model are summarized in [Table 4](#), the following description focuses on 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.⁶

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 groups 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. On the demand side, imported and domestic goods are treated as imperfect substitutes in both final and intermediate demand. In line with assumptions for a small country, Egypt faces an infinitely elastic world supply at fixed world prices.

There are seven labor groups in the model: unskilled, semiskilled, and skilled labor in both urban and rural regions, as well as family labor (also known as mixed labor), which consists of smallholders (and their family members) in agriculture and self-employed workers (and their family members) in manufacturing and services sectors. There are also three types of capital that 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. Family labor is assumed to be fully employed but sector-specific, rather than mobile, both in the short and long term. This means the remuneration of family labor depends on commodity demand. If demand increases, remuneration will increase; if demand slackens, it will directly reduce family labor income. In the short run, economy-wide average wages for hired labor are assumed to be fixed with labor demand being determined by the changes of sectoral real producer wages. Thus, increasing sectoral real producer wages will lead to increasing unemployment, and vice versa.

Capital is assumed to be fixed and sector-specific in the short term (i.e., within each year); however, in the medium to long term, new capital generated from the previous year's investment is allocated to sectors according to profit rate differentials (i.e., “putty-clay” assumption). Again, the exceptions are the 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 total amount of available 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 the observed data from the national SAM that captures the initial equilibrium structure of the Egyptian economy in the fiscal year 2012/13 (labelled 2012 in the model and the simulations). Exogenous parameters are then adjusted over years to reflect demographic and economic changes, and the model is re-solved for a series of new equilibria for the period of 2012–2025.⁷ Furthermore, between periods the model is updated to reflect exogenous rates of land and labor expansion (for crude oil and natural gas production capital and output expansion are pre-specified). 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 then added to previous capital stocks after accounting for the long-term rate of depreciation. Finally, the model captures total factor productivity growth through the shift parameter of the production function, with the rate of technical change being determined exogenously.

In order to isolate the impacts of the energy subsidy reform steps and accompanying social measures, we simulate three different

⁶ The core GAMS (General Algebraic Modeling System) model code together with the SAM for Egypt are available from the authors.

⁷ The simulation period covers the years 2012–2025, and we report results for two periods: (1) 2014 to 2017—both short-run and long-run impacts depending on labor market adjustments—and (2) 2012 to 2025 for the long-run impacts of the complete phaseout of energy subsidies.

Table 4

Equations of the Egypt dynamic computable general equilibrium model.

Source: Authors' compilation based on [Diao and Thurlow \(2012\)](#).

I. Prices		IV. Income and flow of funds; endogenous variables calculated	
$PM_i = pwm_i(1 + tm_i)\bar{R}$	(1)	Y_h : income of households	(15)
$PE_i = pwe_i/(1 + te_i)\bar{R}$	(2)	Y_G : government revenues	(16)
$PQ_i = f(PM_i, PD_i)$	(3)	S : total investment	(17)
$PX_i = g(PE_i, PD_i)$	(4)	IV. Sectoral demand and product markets	
$PV_i = PX_i - \sum_j a_{ij}PQ_i$	(5)	$I_i = \phi_i S$	(18)
$CPI = \sum_i \Omega_i PQ_i$	(6)	$Z_i = \sum_j b_{ij}I_j$	(19)
$DPI = \sum_i \psi_i PD_i$	(7)	$V_i = \sum_j a_{ij}QX_j$	(20)
II. Production, employment, and wage rates		$C_i = \sum_h q_{ih}(1 - s_h)Y_h/PQ_i \quad j = g, G$	(21)
$QX_i = f(\bar{K}_i, L_{fi})$	(8)	$D_i = d_i(V_i + C_i + Z_i)$	(22)
$W_f = PV_i(\delta QX_i/\delta L_{fi}, f = \text{labor, land})$	(9)	$d_i = 1/f_i(M_i/D_i, 1)$	(23)
$LD_f = \sum_i L_{fi}$	(10)	$XD_i = D_i + E_i$	(24)
$LD_f - \bar{L}S_f = 0$	(11)	$XD_i - QX_{i=0}$	(25)
III. Foreign trade		V. Dynamics	
$E_i = h(PE_i/PD_i)$	(12)	$LS_{ft} = LS_{ft-1}(1 + \varphi_f)$	(26)
$M_i = m(PM_i/PD_i)$	(13)	$LS_{ft} = LS_{ft-1}(1 - \eta) + \sum_i \frac{PQ_{ft-1}I_{ft-1}}{\kappa}\varphi_f$	(27)
$\sum_i pwm_i M_i - \sum_i pwe_i E_i - \bar{F} = 0$	(14)	$\alpha_{it} = \alpha_{it-1}(1 + \eta_i)$	(28)
Subscripts		Endogenous variables	
f	factor groups (labor, capital, and land)	PM	import price
h	household groups	PE	export price
i, j	sectors	PQ	commodity price
t	time periods	PX	output price
<u>Exogenous variables</u>		PV	unit value added
\bar{R}	nominal exchange rate	CPI	consumer price index
\bar{F}	foreign savings balance	DPI	producer price index
pwm	world import prices	QX	output quantity
pwe	world export prices	M	import quantity
<u>Exogenous parameters</u>		E	export quantity
α	factor productivity	L	labor and land demand quantity
Ω	consumer price index weights	W	average factor return
Ψ	producer price index weights	L	factor demand quantity
ϕ	investment allocation shares	Y	household income

Table 4 (continued)

b	capital composition coefficients	YG	government revenue
a	input-output coefficients	S	total investment
q	expenditure shares	I	investment by sector of destination
s	savings rates	Z	investment by sector or origin
tm	tariff rate	V	intermediate demand
te	export subsidy rate	C	consumption demand
ϕ	land and labor supply growth rate	D	domestic demand
η	capital depreciation rate	d	domestic demand ratio
γ	Hicks neutral rate of technical change	XD	total demand for domestic output
κ	base price per unit of capital stock	f(–)	CES cost function
		g(–)	CET revenue function

scenarios:

- 1. Baseline (reference) scenario:** This scenario represents Egypt's economic development along its path in the absence of the reforms that were initiated in 2014 and continued in 2016 and 2017. Most importantly, it is assumed that the government fully controls domestic prices of fuel commodities. This means that within the framework of the DCGE model “base” simulations, we assume fixed prices of the fuel commodities for the whole simulation period. In the following text we will refer to the baseline scenario as “BASE”.
- 2. Energy subsidy reform scenario (ESR1 simulations):** Within this scenario, we consider two stages of the energy subsidy reform: the period of 2014–2017 that simulates already observed price changes for the energy commodities, and the period of 2014–2025 that in addition (and consistent with the GOE plans) assumes further increases in energy prices until subsidies are completely phased out. We introduce price changes in the model as uniform growth rates of average registered prices of energy commodities. Prices changes of the energy commodities (from 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](#) (Table 1). To simulate the complete phaseout of subsidies, we make several important assumptions. First, we use information from the IMF country report (2017) estimating a price-to-cost ratio for gasoline and diesel of 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 the growth rates of the energy commodity prices and the cost-recovery ratio. Last, but not least, we assume that the objective of 100 percent cost recovery should be reached by 2021⁸ as a result of identical year-to-year growth of registered prices starting from 2018. Given these assumptions, we project that prices of all energy commodities will increase by 10.12 percent each year during the period of 2018–2021 in order to gradually phase out energy subsidies.
- 3. Energy subsidy, food subsidy, and cash transfers reform scenario (ESR2 simulations):** In addition to the previous scenario, this set of simulations assumes an increase of food subsidies and cash transfers from the government. In particular, it is assumed that all food subsidy rates (negative sales taxes of food commodities) are

⁸ We use the year 2021 as a target year for complete subsidy abolishment based on the most recent comments of the Electricity Minister of Egypt Mohamed Shaker regarding the phasing out of electricity subsidies ([Reuters, 2017](#)).

Table 5

Subsidy rates of selected food commodities, 2014–2017, percent.

Source: Own estimations based on CAPMAS, 2016; MoF, 2017a.

	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

Table 6

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

Source: Own calculation based on Breisinger et al., (2018).

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

changing uniformly in line with the budgeted increase of the food subsidies program (Table 5). The growth rates of cash transfers to poor rural and urban households are based on information from the Ministry of Social Solidarity (Table 6).

Each scenario is simulated for four different combinations of economic assumptions (closures) that include the following:

- Two possibilities for the use of the government savings from the energy subsidy reform (saving-investment closure): (1) saved funds are used to finance investment exclusively, or (2) saved funds finance both public investment and consumption.
- Two assumptions for the labor markets: (1) 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, (2) under the assumption of full employment, wages adjust to economic shocks and the growth of labor supply is restricted by the growth rates of the population. These simulations reflect long-term economic developments.

4. Impacts of reform program on the economy and households

This section examines the effects of the energy price reform based on the DCGE model. Because we are primarily interested in the impact of the reform on income distribution and household welfare, a strong emphasis is given to the adjustment of production sectors and consequent sectoral, functional, and household income distribution.

Table 7 presents changes in the major GDP components under alternative economic assumptions. The results confirm expectations and reflect findings for other countries. Higher energy prices reduce real GDP and absorption in the short term (columns 2 and 3) but have positive impacts in the long term (columns 4 to 7), even under further increases of energy prices, until the complete phaseout of subsidization (columns 6 and 7). The model suggests that higher energy costs in combination with rigid wages lead to an increase of sectoral real wages (due to the explicit relationship of wage rate to output price) in the short run, which in turn forces producers to reduce production and release workers. This increases unemployment and reduces real GDP growth and absorption by 2.8 and 2.3 percent, respectively. The reduction of production and employment is more pronounced in energy-intensive sectors with a high share of hired labor inputs (considered below). The indirect wage and employment effects are less pronounced in the long term, as flexible wages and inter-sectoral labor mobility lead to the reallocation of hired labor between sectors. In turn, higher investment and reallocation of factors toward less energy-intensive sectors following the phaseout of remaining subsidies over the period of

2018–2021 is expected to increase both real GDP growth and total absorption. As shown in columns 6 and 7 in Table 4, 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 use of the government savings from the reform (higher investment spending generates higher future growth and, consequently, absorption).

The extent to which subsidy savings are used for consumption or investment also affects the foreign trade balance. Since investment demand⁹ is import intensive, any change in it affects imports and the trade balance. While import demand generally is expected to shrink, the reduction is less pronounced when the additional fiscal space is used to finance investment only (columns 2, 4, and 6). When the subsidy savings are used to finance both investment and consumption, imports are reduced by 1.8 and 3.3 percent in the short run and the long run, respectively, compared to a reduction by 1.5 and 0.1 percent if the savings from subsidy reform are used for investment only.

Individual economic sectors in turn are affected differently, ranging from a boom in the construction sector to a decline in manufacturing output (Table 8). At the same time, mining and construction are the only sectors that are expected to benefit from the reform both in the short and long term. Real GDP generation in mining (including crude oil and natural gas production) increases slightly in the short term (columns 2, 3, 4, and 5), and the growth is more pronounced in the long run with the complete phaseout of subsidies (columns 6 and 7). This effect can be traced back to the pre-specified production growth of the crude oil and natural gas sectors, which dominate mining activity. Income generation in the construction sector increases between 1.6 and 8.2 percent in the short run, depending on labor market flexibility and the use of subsidy savings. The benefits are solely attributable to booming investment demand, which overcompensates the losses resulting from higher intermediate input costs. Construction is largely a nontradable good with low import and export shares, meaning that domestic prices are largely determined by domestic supply and demand, rather than world market prices. Therefore, the investment boom directly transmits to higher demand and prices for construction services (according to the SAM, 78 percent of total supply of construction is used for investment). This is why the construction sector is the major beneficiary of the reform from the supply side. Construction is also used as an important intermediate input for other sectors. In turn, the increase in construction prices together with the increase in prices for energy intermediates raises costs and hampers production in other sectors. The losses of real income are highest in other manufacturing sectors, particularly textiles, machinery, and vehicles; utilities, including electricity and water; and the transport sector, all of which heavily depend on energy inputs (Table 2).

In the long term, more economic sectors are expected to benefit from the reform, including agriculture, agroprocessing, and nontransport services. Higher investment, mobility of labor, and the adjustment of wages allows for effective reallocation of resources from energy-intensive to energy extensive sectors, resulting in both increased real GDP growth and absorption.

⁹ Important investment goods are construction (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.

Table 7

Short-term and long-term macroeconomic impacts of energy price reforms under alternative spending options of subsidy savings, percentage change from BASE.
Source: Egypt DCGE model

	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 & consumption	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption
	[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

Table 8

Short-term and long-term sectoral impacts of energy price reforms under alternative spending options of subsidy savings, percentage change from BASE.
Source: Egypt DCGE model

	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 & consumption	Savings finance investment	Savings finance investment & consumption	Savings finance investment	Savings finance investment & consumption
	[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
Nonenergy	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
Agroprocessing	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

Yet, despite these overall gains and positive impacts on several sectors, the impact on household consumption in the short and long term is projected to be negative (Table 9). Reduction of energy subsidies improve the economic growth prospects over time, but lead to lower private (household) consumption by 1.4–6.5 percent (Table 7). The total reduction of private consumption is largest if subsidies are phased out and part of the savings from energy subsidies abolishment is used for consumption. If we assume that absorption shares for private and government consumption and investment are kept constant, government consumption of nontradable public goods is expected to increase by more than 35 percent over the period of 2014–2025. Thus, in the long term, the energy subsidy reform not only increases energy prices and intermediate input cost, but also the cost of public services, thereby hampering growth 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 households' welfare differently.¹⁰ As shown in Table 9, almost all

households experience welfare losses, both in the short term and the long term.

The exceptions are 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 explained 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 term and with flexible labor markets (Table 9, 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 on average experience a stronger negative impact of higher energy prices than urban households, despite their lower energy spending share, which is a clear indication of the relative importance of indirect general equilibrium effects. In addition, rural poor households and urban high-income households benefit most from labor market flexibility in the short run.

Within all household groups, high-income households in rural areas and poor households in urban areas tend to be the most heavily affected

¹⁰ We measure household welfare by the Hicksian equivalent variation, which takes into account price changes.

Table 9

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

Source: Egypt DCGE model

	Base year (2012)	Short-term (2014–17) fixed wages		Short-term (2014–17) flexible wages		Long-term (2014–25) flexible wages	
	Consumption shares	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]
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 medium-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 medium-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

by the reform. The notable beneficiary group is urban high-income households, which loses only slightly in the medium term and even benefits in the long term (Table 9), when investment boom leads to expansion of construction.

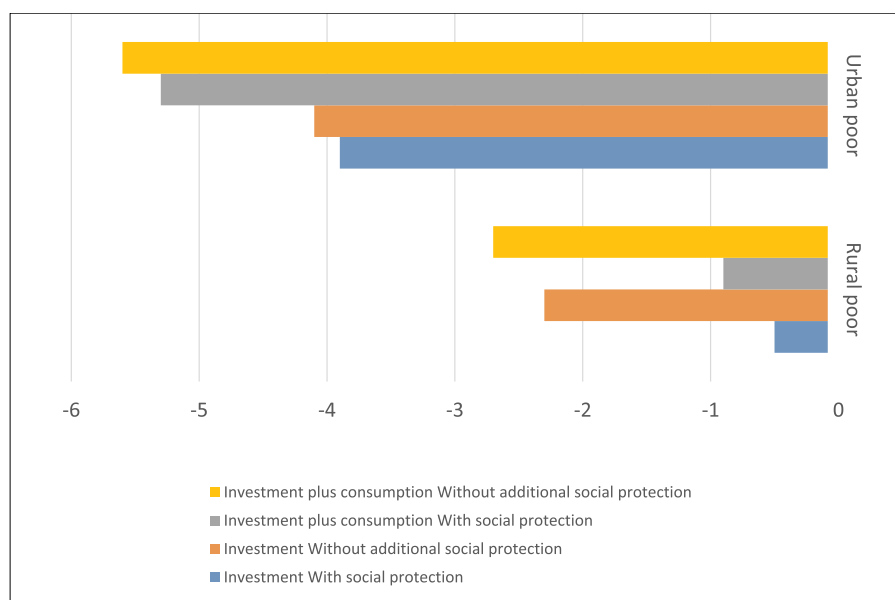
The increase of food subsidies and the introduction of the cash transfer program helped to mitigate the negative impact for poor households. Our estimates suggest that without these social measures, welfare losses would have been between 4.1 and 5.3 percent for urban poor households and between 2.3 and 2.7 percent for the rural poor (Fig. 3). The two measures combined increase poor households' welfare by about 2.0 percentage points in rural areas, but only by 0.3 percentage points in urban areas. Both measures lower consumption losses of poor households. However, cash transfers tend to be more effective in protecting the poor, as they are targeted at the lowest rural and urban income quintiles, while the direct price effects and indirect income effects of food subsidies benefit all households.

However, there is room to further expand the social safety net program, as not all poor households are able to maintain their pre-

reform consumption levels, especially when energy subsidies are completely phased out until the year 2021. This effect is expected, as the cash transfer 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 cash transfer programs, only the poorest rural households—the lowest income quintile—are able to keep their consumption level constant in the wake of higher energy prices in the short term. Moreover, the poorest rural households tend to slightly benefit from the reform package in the long run, as the reallocation of factors to energy-extensive and tradable sectors leads to an increase of the remuneration of self-employed and family workers. Finally, the results suggest that the decision to completely phase out energy subsidies over the period from 2018 to 2021 requires additional support to protect the poorest households.

5. Conclusions and policy recommendations

Only a few countries in the world have implemented a

**Fig. 3.** Average annual change in household welfare during 2014–17 (percent).

Source: Egypt DCGE model.

comprehensive economic reform package that is comparable in terms of time and scope to the reforms that have been launched in Egypt (Alleyne et al., 2013, Table 4.1). Political considerations often hinder economic reform, especially when the beneficiaries of the subsidy are large in number and highly diffuse in the public, like in the case of energy subsidies (Inchauste and Victor, 2017). Therefore, government leadership and strength is seen as an important precondition for the adoption of energy policy reforms (Acemoglu and Robinson, 2006). A major 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. In 20 of 28 major reform episodes summarized by Alleyne et al. (2013), subsidy reform was accompanied by specific measures to mitigate the impact of price increases on the poor. In seven episodes, price increases were initially concentrated on products that were less important for poor households' budgets.

Early evidence from Egypt's case 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 macroeconomic impacts are likely to increase over time if the reform program is sustained. This is confirmed by other country studies. The case studies mentioned above show that 17 out of 23 reform episodes that were successful or partially successful involved a phased reduction of subsidies. In addition, the model results suggest that the increase in food subsidies and the introduction of the cash transfer program helped to mitigate the negative impacts of the reform on households, especially for rural poor households. Several key policy 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 macroeconomic 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 phaseout 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 households. Our results suggest that continuing the gradual approach of

subsidy phaseout is preferable to immediate abolishment in order to give economic sectors and households time to adjust to higher energy prices.

However, there are several measures that can accelerate the positive impacts of reform. The literature suggests that provisions that serve the 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 for labor mobility, especially for unskilled workers.

Social protection measures should be continued and scaled up in parallel to the phaseout of energy subsidies. Our findings show that the expansion of the food subsidy program and the introduction of cash transfers have helped to protect the people from the short-term negative impacts of the reform. However, the complete phaseout of energy subsidies over the 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 in Egypt are not well targeted. Targeted cash transfers to the poorest rural and urban households are more effective and efficient in protecting the most vulnerable.

Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Appendix. MACRO SOCIAL ACCOUNTING MATRIX FOR EGYPT, 2012/13, BILLIONS EGP

Revenues/ Expenditures	Activities	Commodities	Transaction costs	Factors		Institutions			Capital ac- count	Rest of the world	Total
				Labor	Capital	Land	Enterprises	House- holds	Government		
Activities		3032									3032
Commodities	1212		276					1418	211	303	3743
Transaction costs		276									276
Labor	987										987
Capital	811										811
Land	22										22
Enterprises				399	645			21	96	– 36	1125
Households				588	166	22	874		5	116	1770
Government		– 71					112	39		1	82
Capital account							139	292	– 231	47	350
Rest of the world		506								102	506
Total	3032	3743	276	987	811	22	1125	1770	82	350	506

Source: CAPMAS, 2016.

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