



Food Subsidies and Cash Transfers in Egypt

Evaluating general equilibrium benefits and trade-offs

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ABSTRACT

Most Egyptians receive food subsidies, which are the cornerstone of the country's social protection system. The government recently attempted to reduce subsidies, with limited success, and introduced a cash transfer program targeting the poor. We use a dynamic general equilibrium model of the Egyptian economy to evaluate the growth and distributional impacts of subsidy reforms and cash transfers. We find that the welfare of poor households would be enhanced by a smaller, but better targeted food subsidy program, and that, if the cost savings from reforms are channeled into investment, faster economic growth would eventually outweigh any short-term welfare losses. However, most of the gains from subsidy reforms accrue to nonpoor households. Combining subsidy reforms with cash transfers leads to the largest welfare gains for the poor, while leaving the welfare of nonpoor households largely intact. The latter is crucial to maintaining support for ongoing subsidy reform efforts.

1 INTRODUCTION

Food subsidies are a traditional pillar of the social contract in Egypt. Since the 1940s, the government has subsidized staple foods for most Egyptians and, despite reforms over the years, these Tamween subsidies remain one of the country's largest social programs, accounting for about 4 percent of public spending over the period 2016 to 2020 (MOF 2019a). There are, however, major costs to this general subsidy. Due to poor targeting, the fiscal burden is high relative to other social protection policies, and food consumption patterns are distorted by subsidized prices. As pressures on public budgets rise and Egypt's government debt accumulates, questions about the cost-effectiveness and sustainability of the Tamween food subsidy program have become more urgent.

A well-established literature describes how price distortions from food subsidies can lead to inefficient resource allocations and even welfare losses. Gentilini (2016) reviews the merits of food subsidies versus cash transfers and finds that poor targeting of beneficiaries is a major concern for food subsidy programs. This is true in Egypt, where poor households receive only a third of the total value of food subsidies. This pattern is common throughout the Middle East and North Africa – less than half of the benefits of food subsidy programs in the region are received by households in the lowest two quartiles (Sdravovich et al. 2014). Moreover, in Egypt, food subsidies are associated with *negative* health outcomes, because they incentivize overconsumption of calorie-dense staple foods (Ecker et al. 2016). Thus, in addition to the high fiscal cost of Egypt's food subsidies, there are additional concerns about their effectiveness in improving household welfare.

A common approach to food subsidy reform is to pair the removal of subsidies with the scaling up of cash transfers to preserve social protection for poor households, but with better targeting and more efficient delivery (Sdravovich et al. 2014). In 2015, Egypt introduced a national cash transfer program called Takaful and Karama (TKP) that targets poor households (World Bank 2015). Implementation of TKP has been largely successful, with about one in ten Egyptians now receiving transfers (Breisinger et al. 2018).

While the relative advantages of cash transfers vis-à-vis food subsidies are well researched, the macroeconomic implications of public spending on social safety net programs are not as well addressed in the social protection literature, especially for developing countries. To finance large programs, governments must raise revenues, reduce spending elsewhere, or borrow. Higher taxes and lower investment spending can slow down economic growth and job creation, making social safety net programs less sustainable and possibly worsening food security in the long run (Barrett 2002). The effect of government borrowing on economic growth hinges on whether the funds are used to finance *productive* investments (Adam and Bevan 2005). Unfortunately, there is little evidence directly linking cash transfers to the productivity of poor households (Bastagli et al. 2016), or confirming that productivity gains, where they do exist, are enough to offset program costs. In many countries, the cost of a social protection program may not need to be directly recoverable or "growth neutral". However, in Egypt, where social protection accounts for such a large share of public spending and national income, it is essential to consider such macroeconomic factors in the design and implementation of its safety net programs.

The few studies that do consider the fiscal and growth implications of such programs usually focus on short-term outcomes, and offset social protection spending with higher taxes rather than larger deficits. Coady and Harris (2004), for example, model the general equilibrium effects of Mexico's transition from universal food subsidies to targeted cash transfers. They impose a strict fiscal constraint, i.e., changing subsidies and cash transfers does not alter the fiscal deficit, and, as

such, focus on the distributional effects of alternative taxes and transfers, rather than on program costs and sustainability. Other economywide studies, such as Karami et al. (2012), do not focus on financing issues, but rather on the economywide impacts of removing price and consumption distortions.

Egypt's food subsidy program has been analyzed extensively, including in studies that use computable general equilibrium (CGE) models of the Egyptian economy. Lofgren and El-Said (2001) find small aggregate welfare gains from removing food subsidies, with rural households benefiting when consumption shifts from imported wheat to domestic foods. Welfare gains are highly regressive, however, with consumption falling for poor households. To avoid this, the authors recommend better targeting of subsidies. More recently, Helmy et al. (2019) simulate switching from food subsidies to cash transfers. The authors also find regressive welfare changes, even with cash transfers, and recommend additional health and education spending targeting the poor. Both studies use static models and impose balanced budgets, and, so, do not consider the implications for economic growth and program sustainability. Finally, other recent studies model cash transfers in Egypt, but their focus is on mitigating the effects of energy subsidy reforms, and the cash transfer scenarios are fairly stylized rather than reflecting the actual TKP (Banerjee et al. 2017; Griffin et al. 2016).

We evaluate the economywide impacts of food subsidy reforms and cash transfers in Egypt. Like previous studies, we estimate the distributional impacts of food subsidies versus cash transfers using a CGE model that captures how social protection aimed at households affects the broader economy, including non-beneficiaries. Our model scenarios are informed by a recent survey-based impact evaluation of TKP (Breisinger et al. 2018), and by recent reviews of the Tamween system (Ecker et al. 2016; Abdalla and Al-Shawarby. 2017). Unlike previous studies, we use a dynamic model to assess both short-term impacts on welfare over the period 2015 to 2022 and longer-term impacts on fiscal deficits and economic growth through to 2030. This is important for Egypt, where concerns about fiscal sustainability underpin much of the ongoing debate about the future of social protection in the country.

Section 2 of the paper reviews the Tamween system and TKP, focusing on program design, targeting, and costs. Section 3 describes the CGE model and its data sources, and Section 4 presents the findings from our simulation analysis. We simulate recent and proposed food subsidy reforms, as well as alternative scaling and targeting of cash transfers. Outcomes are reported at macroeconomic and household levels. The final section summarizes our findings and policy recommendations.

2 FOOD SUBSIDIES AND CASH TRANSFERS IN EGYPT

2.1 Food subsidy system

The Tamween food subsidy system is an integral part of Egypt's social safety net program. It includes a combination of food rations and bread allowances. Beneficiary households receive a smart card containing 50 Egyptian Pounds (EGP) per person per month (about US\$ 3.00) that can be used to purchase subsidized food and nonfood items from designated Tamween shops. The beneficiary pays a 5 to 10 percent fee on each transaction. With the same smart card, beneficiaries also receive a Baladi Bread allowance of five loaves per person per day at EGP 0.05 each (Ecker et al. 2016; Kassim et al. 2018). This is a substantial subsidy compared to the market price of EGP 0.50 per loaf and is equivalent to an additional EGP 68 per person per month. Unused Baladi Bread allowance can be converted into a smart card allowance, but it cannot be carried over to the next month.

The Tamween system has wide coverage, with three quarters of Egyptian households benefiting in 2015 (Table 1). While coverage declined following recent reforms, nearly 65 percent of households still received food ration cards in 2019, and 73 percent benefited from the bread subsidy (MSIT 2019). Moreover, issues with registration mean that household members who have moved or died may still receive benefits. As a result, there are 82 million beneficiaries registered, which is well above the 69 million actual beneficiaries (Ecker et al. 2016). Coverage is lower for poor households, i.e., those with average per capita consumption levels in the bottom two quintiles, especially after accounting for the high ratio of registered-to-actual beneficiaries amongst nonpoor households. Overall, the subsidies provided to poor households accounted for only a third of the total cost of the Tamween food subsidy system in 2015.

Table 1. Tamween food subsidy program coverage and costs in 2015

	Total	Poor	Nonpoor
Egyptian households (1,000s)	21,458	6,923	14,535
Share of total households (%)	100.0	32.3	67.7
Beneficiary households (1,000s)	16,083	5,061	11,022
Share of households (%)	75.0	73.1	75.8
Registered beneficiary individuals (1,000s)	82,200	27,122	55,078
Actual beneficiary individuals (1,000s)	68,591	27,382	41,209
Registered / actual (ratio)	1.20	0.99	1.34
Total direct cost (EGP millions)	37,700	12,439	25,261
Share of total direct cost (%)	100.0	33.0	67.0
Administration cost (EGP millions)	6,653	-	-

Source: Authors' calculations using data from Abdalla and Al-Shawarby (2017) and Ecker et al. (2016).

Note: Poor population defined as those in the two bottom per capita consumption quintiles.

We take 2015 as the baseline year for our evaluation, because it coincides with the introduction of TKP cash transfer program. However, this date predates recent attempts to improve the targeting of Tamween subsidies by tightening and enforcing eligibility criteria and reducing administrative inefficiencies (Abdalla and Al-Shawarby 2017). By 2019, attempts to eliminate ineligible beneficiaries had reportedly removed eight million people from the system. This elimination was based on income levels, as well as proxy indicators, such as electricity consumption, vehicle ownership, public sector employment, and having children enrolled in private schools. Reports in 2019 suggested that the government planned to remove 40 million beneficiaries (Enterprise Press 2019), but this appears to have been scaled back in response to widespread protests. No further reforms to the Tamween food subsidy program had been publicly announced as of late-2020. In our model scenarios, we simulate both the implemented and the planned reforms, as well as a scenario that eliminates all food subsidies.

2.2 Cash transfer program

The Takaful and Karama cash transfer program was introduced in March 2015. The Takaful component targets poor households with children under the age of 18. The transfer amount depends on the number of registered children and their educational status and is paid to households via smart card. Transfers initially included a base payment of EGP 325 per household per month, plus EGP 60 for children under six years of age and between EGP 80 and EGP 140 for children in primary, preparatory, or secondary school (World Bank 2015). Takaful households could initially register up to three children, but this was reduced to two in 2020 as part of the country's "two is enough" campaign. The base payment was increased to EGP 425 in 2017 to account for inflation (MOF 2019b). To qualify for Takaful, children should have 80 percent attendance during the school year and children under two years of age should regularly visit health

clinics. However, there is no information yet on enforcement or how such conditionalities affect the distribution of benefits.

The Karama component targets the disabled, elderly, and orphaned. Disabled and elderly beneficiaries receive a monthly payment starting at EGP 450, and orphans receive EGP 350 per month, with a maximum of three beneficiaries per household (World Bank, 2015). Beneficiaries receive the cash transfers via smart card. A recent evaluation of TKP confirmed that transfers are received effectively, and that the average beneficiary household increases their consumption spending by at least 8 percent (Breisinger et al. 2018). The study also confirmed the nutritional benefits of cash transfers over food subsidies, with beneficiaries consuming more higher-value food items, such as fruit and poultry.

TKP's targeting mechanism includes geographic targeting, self-selection, and a proxy means test (PMT). Program registration and promotion initially started in districts with high poverty rates – mainly rural areas in Upper Egypt. To enroll in TKP, households must apply at a local government office where they provide information used to calculate a PMT score. Households with scores below a set threshold and that do not meet other exclusionary criteria, such as receiving foreign remittances, owning a vehicle, or owning land, are eligible for the program. Less than half of households who register are accepted. TKP's targeting of poor households has been quite successful by global standards, but its PMT methodology does lead to some inclusion error (Kurdi et al. 2018), with nonpoor households making up a third of the two million households benefitting from the program in 2018 (Table 2). Moreover, given its current scale, TKP only reaches about a fifth of poor households. In our analysis, we include a model scenario simulate expanding TKP to reach all poor households, but at higher program costs.

Table 2. Takaful and Karama cash transfer program coverage and costs in 2018

	Total	Poor	Nonpoor
Egyptian households (1,000s)	22,768	7,346	15,423
Share of total households (%)	100.0	32.3	67.7
Beneficiary households (1,000s)	2,042	1,379	663
Share of households (%)	9.0	18.8	4.3
Average benefits per household (EGP/month)	455	469	425
Total direct cost (EGP millions)	11,149	7,763	3,386
Share of total direct cost (%)	100.0	69.6	30.4
Administration cost (EGP millions)	1,239	-	-

Source: Authors' calculations using data from Breisinger et al. (2018) and World Bank (2015).

Note: Poor population defined as those in the two bottom per capita consumption quintiles.

2.3 Direct and administrative costs

There were 16 million beneficiary households in the Tamween food subsidy system in 2015 (Table 1), compared to 2 million households receiving TKP cash transfers in 2018 (Table 2). However, the average value of food subsidies per household per month (EGP 195) is much lower than the average cash transfer payment (EGP 455), so the difference in the total costs of the two programs is smaller. In 2018, TKP's direct cost, i.e., number of beneficiaries times average benefit, was EGP 11 billion (US\$ 710 million), while the direct costs for Tamween in 2015 was EGP 38 billion (US\$ 2.4 billion at the same 2018 exchange rate). Together, the two programs are equivalent to about 4 percent of total government spending, and almost 5 percent of total spending once the estimated costs of administering the programs are included. The scale of Egypt's social protection system underscores why it is important to consider the fiscal sustainability and economywide impacts of these programs.

3 ECONOMYWIDE MODEL AND DATA

To evaluate the macroeconomic and distributional impacts of Tamween and TKP, we use a dynamic CGE model that captures the interactions between all economic actors in Egypt, including producers, consumers, and the government (Diao and Thurlow 2012).

The model divides Egypt's economy into 86 sectors using information from a 2014/15 social accounting matrix (SAM) (CAPMAS and IFPRI 2019).¹ Producers in each sector combine labor and capital with intermediate inputs, and then supply their output to national product markets.² Labor is differentiated by rural and urban areas and by education levels. The exact combination of workers, capital (e.g., land and machines), and other inputs needed to produce goods and services varies by sector and product type and adjusts in response to changes in input prices. If removing food subsidies leads to greater demand for domestically produced food, then the farmers and factories supplying this food and the workers they employ will benefit from higher prices, wages, and profits. The model captures adjustment costs by making capital sector-specific, meaning that once installed, it is not possible to reallocate machines and buildings to other sectors without additional investment spending. Labor can move across sectors, but the total labor supply is fixed, and, so, expanding production in one sector may require drawing workers, as well as other inputs, from elsewhere in the economy, usually by offering higher wages (prices).

The model captures Egypt's interactions with the rest of the world, including the importing and exporting of goods and services. Producers choose whether to supply local or foreign markets, and consumers choose between local and imported products, based on relative prices, net of any taxes and transaction costs. The model allows for imperfect substitution between domestic and foreign products, because this better reflects product differences, consumer preferences, and marketing constraints. Egypt's *real* exchange rate is assumed to adjust to maintain a fixed current account balance. If removing food subsidies reduces demand for imported wheat, for example, then the real exchange rate will appreciate and make other imports cheaper for local producers and consumers.

The model separates Egypt's population into 15 representative groups based on their rural/urban location, national per capita consumption quintile, and, within rural areas, whether their household earns any income from farming. Households in the model earn land, labor, and capital income, based on their asset endowments, and can receive government transfers and remittances from abroad. Households then pay taxes, consume goods and services, and make their own transfers. A portion of income is saved based on fixed marginal savings rates. The detailed SAM allows the model to capture each household group's unique income and expenditure patterns. Income elasticities for each product in the model are estimated for rural and urban households using the national consumption survey. The model therefore captures how alternative targeting mechanisms for cash transfers can lead to different changes in national consumption patterns. The model also tracks how food subsidies and, hence, market prices vary across products and household groups and how the beneficiary population changes under different eligibility criteria. This detailed treatment of households allows the model to capture the distributional impacts of Egypt's social protection programs.

The final economic actor in the model is the government. The government collects taxes on products, households, and enterprises and uses these to pay for recurrent spending, including food subsidies and cash transfers, and to make capital investments. If expenditures exceed revenues, then the government must either raise taxes or increase domestic or foreign borrowing. If the

¹ 2014/15 refers to Egypt's fiscal year, which runs from July 2014 to June 2015. It slightly overlaps the initial introduction of TKP in March 2015 and, therefore, is the most suitable pre-TKP baseline year for the evaluation.

² Tables A1 and A2 in the Appendix present the model's indices, parameters, variables, and equations.

government borrows domestically to finance social protection programs, then it may crowd-out private investment, because total investment in the economy is determined by the total supply of loanable funds, i.e., total public and private savings plus foreign capital inflows. Conversely, if removing subsidies reduces public spending, then the government can either lower taxes, increase public investment, or reduce its borrowing, leading to more private investment. In our analysis, we compare scenarios where either tax rates or the fiscal deficit adjusts.

The model is recursive dynamic, which means that it is updated each year based on past and projected changes in model variables. Growth in rural and urban populations and workforces, for example, are based on demographic projections to 2030. Some changes are driven by mechanisms within the model, such as the rate of capital accumulation, which is determined by past investment spending (net of depreciation) and sector profit rate differentials. We use the model to conduct dynamic counterfactual analysis, which means that we first establish a baseline growth path for the period 2015 to 2030 that replicates recent trends without changing Egypt's social protection programs, i.e., eligibility criteria and coverage. We then run alternative scenarios that impose food subsidy reforms and expand cash transfers. Deviations in model variables from the baseline are solely attributable to the simulated changes in social protection programs. The designs of these scenarios are described alongside our findings.

4 POLICY SCENARIOS AND RESULTS

This section presents three sets of policy scenarios: (i) reforming the Tamween program by gradually moving away from universal food subsidies; (ii) scaling up TKP cash transfers to reach more poor households; and (iii) combining a complete phase-out of food subsidies with expanded cash transfers targeting the poor. We initially focus on short-term impacts during the period 2015 to 2022 under the assumption that any changes to social protection programs leads to changes in tax revenues, rather than the fiscal deficit. This is consistent with most other studies that use CGE models to analyze social protection policies. We then consider the same scenarios, but allow the fiscal deficit to adjust, rather than adjusting tax rates. This allows us to examine longer-term growth and sustainability concerns to 2030.

4.1 Scenario design

Table 3 describes the food subsidy scenarios. The first column shows the Tamween program in the 2015 base year of our analysis. The subsequent columns show projected numbers under the four reform scenarios. The “No Reforms” (baseline) scenario maintains the 2015 coverage of benefits until 2022, including the ratio of registered to actual beneficiaries. Population growth causes the number of beneficiaries and the total cost of the program to increase, but average benefits per person remain unchanged *in real terms*. The “Even Reforms” scenario implements recent and planned reforms by removing 40 million beneficiaries from the program, of which 16 million are removed by reconciling registered and actual family members. The remaining people are removed from the program in proportion to the existing distribution of recipients. In contrast, the “Targeted Reforms” removes 40 million beneficiaries, but only from nonpoor households. Under this scenario, 17 percent of nonpoor households remain in the program by 2022, and the total direct cost of the program is more than halved. Finally, the “Complete Reform” scenario, eliminates food subsidies for all households, reducing coverage, benefits, and costs to zero.

Table 3. Food subsidy scenarios evaluated

	Observed in 2015	No reforms (baseline)	Projection for 2022		
			Even reforms	Targeted reforms	Complete reforms
Households receiving benefits (%)	75.0	75.0	40.2	35.3	0
Poor households	73.1	73.1	39.2	73.1	0
Nonpoor households	75.8	75.8	40.6	17.2	0
Beneficiary households (1000s)	16,083	18,469	9,895	8,689	0
Poor households	5,061	5,812	3,114	5,812	0
Nonpoor households	11,022	12,657	6,781	2,877	0
Actual beneficiary individuals (1000s)	68,591	78,767	42,200	42,200	0
Individuals in poor households	27,382	31,444	16,846	31,444	0
Individuals in nonpoor households	41,209	47,323	25,354	10,756	0
Registered / actual family members	1.20	1.20	1.00	1.00	n/a
Poor households	0.99	0.99	1.00	1.00	n/a
Nonpoor households	1.34	1.34	1.00	1.00	n/a
Registered beneficiary individuals (1000s)	82,200	94,395	42,200	42,200	0
Of which poor individuals (%)	33.0	33.0	39.9	74.5	0
Average benefits per person (EGP/month)	459	459	459	459	0
Direct program cost (EGP millions)	37,700	43,293	19,354	19,355	0
Administration cost (EGP millions)	6,653	7,640	3,415	3,416	0

Source: Authors' calculations using data from Abdalla and Al-Shawarby (2017) and Ecker et al. (2016).

Note: Poor population defined as those in the two bottom per capita consumption quintiles.

Table 4 describes the cash transfer scenarios. The first two columns report observed details of TKP soon after it was introduced in early 2015 and then in 2018 after three years of implementation. The final two columns report 2022 projections under two scenarios that scale up the number of beneficiaries. TKP covered about 2 million households in 2018, or 9 percent of all households in Egypt. The “Current Program” scenario completes the originally planned roll-out of TKP that reaches almost 3 million households by 2022. The “Expanded Program” scenario scales up TKP until all poor households, and no nonpoor households, are beneficiaries. As discussed earlier, perfectly targeting poor households is difficult using TKP’s current PMT methodology. Note that the baseline scenario does not include any TKP cash transfers.³ This means that deviations from baseline in the “Current Program” scenario can be interpreted as the impact of introducing TKP as originally planned.

To account for the fiscal implications of food subsidy reforms and cash transfers, we first allow the government to adjust direct tax rates, e.g., personal income and corporate taxes. Removing food subsidies reduces the fiscal burden and leads to lower taxes, whereas scaling up cash transfers requires higher taxes. To avoid conflating the distributional effects of social protection and tax policy, we assume that direct tax rates are adjusted uniformly across all households and corporations, e.g., the same percentage *point* change. This means that all households across the income distribution experience the same *percentage* change in disposable incomes and consumption, making the tax changes “distribution neutral”. As such, any distributional changes observed in the model can be attributed to changes in the coverage and eligibility criteria of the social protection programs, rather than the tax instrument. We then rerun all scenarios with tax rates fixed and the fiscal deficit allowed to adjust, i.e., the deficit falls with lower food subsidies and rises with more cash transfers. This affects the level of savings and investment when loanable funds are diverted into and out of social programs.

³ Our baseline starting point is the 2014/15 fiscal year ending in June 2015. This is only three months after TKP was launched and before almost any cash transfers were distributed (see Section 3).

Table 4. Cash transfer scenarios evaluated

	Observed program		Projection for 2022	
	2015	2018	Current program	Expanded program
Households receiving benefits (%)	0.9	9.0	11.5	32.3
Poor households	1.8	18.8	24.1	100
Nonpoor households	0.4	4.3	5.5	0.0
Beneficiary households (1000s)	190	2,042	2,834	7,950
Poor households	129	1,379	1,914	7,950
Nonpoor households	62	663	921	0
Average benefits per household (EGP/month)	341	455	382	386
Poor households	352	469	394	386
Nonpoor households	319	425	357	0
Direct program cost (EGP millions)	779	11,149	12,999	36,837
Share for poor (%)	69.6	69.6	69.6	100
Administration cost (EGP millions)	87	1,239	1,444	4,093

Source: Authors' calculations using data from Breisinger et al. (2018) and World Bank (2015).

Note: Poor population defined as those in the two bottom per capita consumption quintiles.

The final “Combined Scenario” combines the “Complete Reforms” scenario, where all food subsidies are eliminated, and the “Expanded Program” scenario, where cash transfers are provided to all poor households. This final scenario considers the potential impact of replacing the Tamween program with an expanded and better-targeted TKP.

4.2 Reforming the Tamween food subsidy system

Column (1) in Table 5 reports baseline results in 2022, while the next three columns report results for the food subsidy scenarios. All scenarios in the table assume that tax revenues adjust in response to reforms, rather than the fiscal deficit.

The “Even Reforms” scenario in column (2) eliminates food subsidies for 40 million beneficiaries, both poor and nonpoor. This increases the food price index by 1 percent relative to baseline and reduces total food consumption for all households by just over 1 percent. Agricultural GDP falls by 0.3 percent relative to baseline, but the decline in agri-food system GDP, which also includes food processing and trade, is even larger at 0.8 percent. Lower agricultural production reduces the returns to farmland by 0.7 percent. Labor returns also fall, because the agri-food system is more labor-intensive than other parts of the economy.

Overall, higher food prices and falling incomes hurt poor households disproportionately, causing their consumption (a proxy for welfare) to fall by almost 1 percent in the “Even Reforms” scenario. In contrast, consumption among nonpoor households rises. This is driven by macroeconomic factors. Lower subsidy payments reduce public spending, allowing the government to reduce direct tax rates. Administrative costs also fall, leading to lower public consumption spending, permitting further tax reductions. Total direct tax collections as a share of GDP falls by 1.1 percentage points – down from 5.6 percent in 2022 in the baseline.⁴ Overall, lower taxes raise the disposable income and savings of households, leading to faster growth in investment demand and capital accumulation. This in turn generates slightly faster total GDP growth, which offsets some of the decline in consumption levels, and partly explains why consumption rises for nonpoor households. Total GDP also rises when demand for imported wheat and other food products falls, as shown by higher net exports.

⁴ For all scenarios in Table 5, there is no change in the fiscal deficit, although its ratio to GDP may change slightly.

Table 5. Model results with direct tax rates adjusting, 2015-2022

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Baseline share or value in 2022	Deviation from baseline in 2022 (%)					
		Food subsidy scenarios			Cash transfer scenarios		
		Even reforms	Targeted reforms	Complete reforms	Current program	Expanded program	Combined scenario
Real GDP market prices	100.0	0.08	0.09	0.16	0.00	0.01	0.17
Absorption	106.7	0.07	0.07	0.13	0.00	0.00	0.13
Private consumption	78.6	0.11	0.11	0.21	-0.04	-0.12	0.09
Food items	25.3	-1.05	-1.02	-1.78	0.06	0.21	-1.60
Non-food items	53.3	0.66	0.65	1.15	-0.09	-0.27	0.90
Poor households	10.6	-0.96	1.05	-2.11	2.67	11.32	9.24
Nonpoor households	68.0	0.27	-0.04	0.57	-0.46	-1.90	-1.33
Public consumption	12.3	-1.09	-1.09	-1.98	0.37	1.06	-0.92
Investment demand	15.8	0.77	0.78	1.36	-0.08	-0.22	1.15
Net exports	33.4	0.12	0.13	0.23	-0.02	-0.05	0.19
Real GDP factor cost	100.0	0.03	0.04	0.07	0.01	0.01	0.09
Agriculture	11.5	-0.30	-0.29	-0.55	0.06	0.18	-0.37
Industry	31.7	0.07	0.09	0.16	0.00	0.00	0.16
Services	56.9	0.08	0.08	0.15	0.00	-0.01	0.15
of which agri-food system	23.9	-0.81	-0.79	-1.38	0.06	0.19	-1.22
Real factor incomes	100.0	0.08	0.09	0.17	0.00	-0.01	0.16
Labor	27.2	-0.27	-0.26	-0.45	0.07	0.19	-0.26
Farmland	4.3	-0.74	-0.70	-1.26	0.13	0.43	-0.85
Capital	68.4	0.28	0.28	0.51	-0.04	-0.12	0.40
Real exchange rate	100.0	0.15	0.15	0.27	-0.01	-0.04	0.23
Real food price index	100.0	0.96	1.00	1.80	0.03	0.10	1.89
Poor households	100.0	1.44	-0.41	3.26	0.03	0.09	3.33
Fiscal deficit/GDP (%)	9.2	-0.01	0.00	0.00	0.00	0.00	0.00
Direct taxes/GDP (%)	5.6	-1.06	-1.05	-1.81	0.69	1.94	0.10

Source: Egypt CGE model results.

Note: Poor population defined as those in the two bottom per capita consumption quintiles. The real exchange rate is the number of Egyptian Pounds per unit of a trade-weighted combination of foreign currency. Fiscal deficit is total revenues minus consumption and recurrent spending and net transfers prior to public investment spending.

An across-the-board removal of food subsidies leaves poor households worse-off and benefits nonpoor households. In the “Targeted Reforms” scenario in column (3), food subsidies for poor households remain unchanged, and 40 million *nonpoor* households are removed from the program. National level results for this scenario mirror those of the “Even Reform” scenario. Removing subsidies reduces overall food demand, causing food prices to rise and food consumption to fall. Lower government spending leads to faster total GDP growth and to higher private consumption. In this scenario, however, real food prices for poor households fall, rather than increase. This is because food subsidies are only reduced for nonpoor households, causing the food prices they face to rise and their food demand to fall. As a result, national food prices, excluding subsidies, also decline. Poor households continue to receive food subsidies and, so, benefit from lower national food prices. Consumption amongst poor households increases in real terms by 1.05 percent, but nonpoor households are slightly worse off, or at least no better off. Consistent with Lofgren and El-Said (2002), we find that better targeting of food subsidies would improve outcomes for poor households. In addition, our dynamic model shows that, when fiscal savings from subsidy reforms are recycled through lower direct taxes, there is slightly faster economic growth that leaves the welfare of nonpoor households largely intact.

Finally, the “Complete Reform” scenario in column (4) of Table 5 gradually eliminates food subsidies for all beneficiaries by 2022. Macroeconomic and distributional impacts mirror those of

the “Even Reform” scenario, although magnitudes are now larger. There is a substantial increase in food prices and reduction in consumption for poor households. Eliminating food subsidies allows the government to greatly reduce direct taxes, leading to even faster economic growth and larger benefits for nonpoor households. However, eliminating all food subsidies, without any compensating transfers, would exacerbate poverty and inequality in Egypt.

4.3 Expanding the Takaful and Karama cash transfer program

Turning to the results from the two cash transfer scenarios, in the “Current Program” scenario in column (5) of Table 5, TKP is rolled out as planned, reaching 24 percent of poor households by 2022 (see Table 4). Six percent of nonpoor households also receive cash transfers due to inclusion errors caused by the PMT targeting methodology. The cash transfers raise consumption amongst poor households by 2.7 percent relative to baseline. However, higher public spending, on both the transfers and administration, requires an increase in taxes to maintain a constant fiscal deficit. Direct taxes as a share of GDP increase by 0.7 percentage points. Higher taxes reduce disposable incomes for all households, but the net effect on consumption remains positive for poor households. Nonpoor households, however, are not the main beneficiaries of the cash transfers, and, so, paying higher taxes causes their consumption to fall by 0.5 percent.

Higher consumption amongst poor households and lower consumption amongst nonpoor households leads to a shift in consumption patterns at the national level. Food comprises a larger share of total consumption spending for poor households, and, so, there is a marginal shift in overall demand towards food products and away from nonfood products. Food prices rise for both poor and nonpoor households alike. There is, however, no significant change in total GDP growth, since the decline in investment demand caused by higher taxes is small. Ultimately, the planned TKP expansion is modest compared to the size of the Tamween program, so the effects on the broader economy are also smaller. That said, the benefits for poor households are larger due to TKP’s better targeting.

In the “Expanded Program” cash transfer scenario in column (6), the coverage of TKP increases to include all poor households and is better-targeted, meaning that there are no nonpoor beneficiaries. The result is a TKP that is almost three times the size of what is currently planned, i.e., about 8 million beneficiaries versus less than 3 million (Table 4). At the national level, the impacts of the expanded program are also about three times larger than under the current expansion plan. However, better targeting means that consumption gains are larger for poor households (11.3 percent), and the fall in consumption for nonpoor households is also larger (–1.9 percent). Maintaining the fiscal deficit by raising taxes avoids significant declines in investment spending and economic growth. However, the required increase in direct taxes is substantial, with their ratio to GDP increasing from 5.6 percent in the baseline to 7.6 percent in the “Expanded Program” scenario. Expanding TKP to cover all poor households may prove prohibitively expensive without compensating reforms.

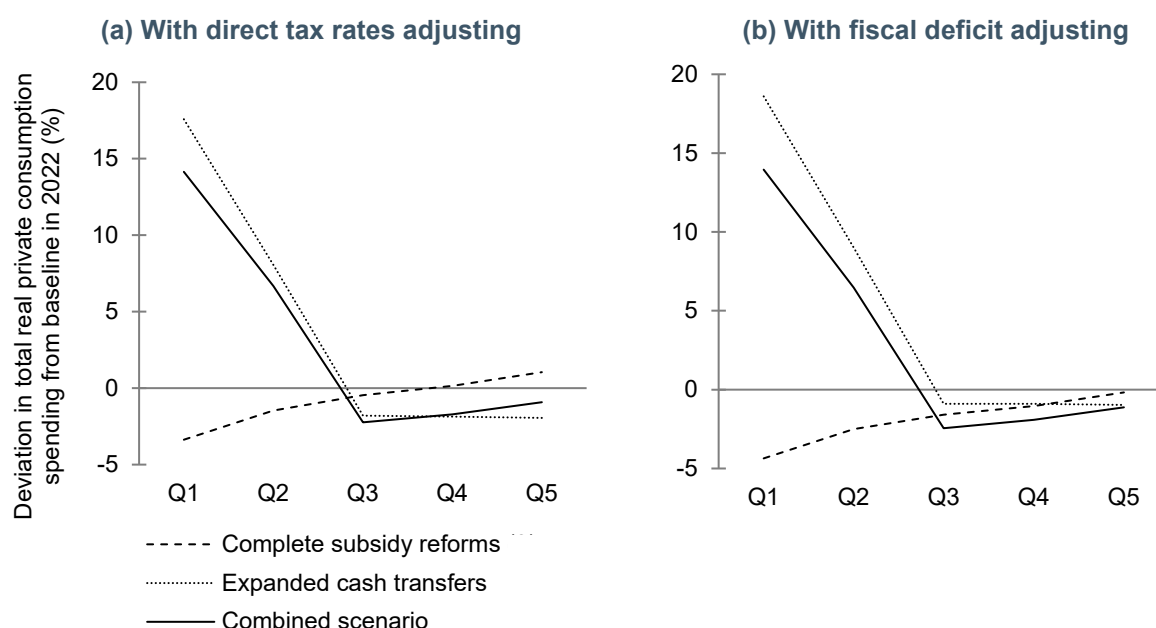
4.4 Replacing food subsidies with cash transfers

Column (7) in Table 5 shows the results of the “Combined Scenario”, which eliminates all Tamween food subsidies by 2022, while, at the same time, expanding TKP to cover all poor households. The combined impacts are, for the most part, the sum of the results from the “Complete Reforms” and “Expanded Program” scenarios in Table 5. The adverse effects of removing food subsidies for poor beneficiaries is more than offset by the targeted cash transfers, leaving total consumption for poor households substantially higher in 2022 by 9.2 percent. Nonpoor households benefit when food subsidies are eliminated, but once the higher taxes needed to

finance targeted cash transfers are included, the net effect is lower consumption for these households by –1.3 percent.

In terms of distributional outcomes, expanding TKP cash transfers dominates the elimination of Tamween food subsidies, leading to lower poverty and inequality. This is evident from the left-hand panel of Figure 1, which shows the deviation in consumption spending from baseline in 2022 for each per capita expenditure quintile. Cash transfers are highly progressive, because they greatly improve consumption for the poorest quintile, while reducing consumption for the nonpoor, i.e., Q3 to Q5. In contrast, eliminating food subsidies is modestly regressive, because it reduces consumption amongst the poorest and increases consumption at the top of the distribution. When the two scenarios are combined, the largest declines in consumption are for households in the middle of the income distribution.

Figure 1. Welfare results by per capita expenditure quintile, 2022



Source: Egypt CGE model results.

Notes: Q1-Q5 are national per capita expenditure quintiles defined in 2014/15 (Q1 is poorest).

Eliminating food subsidies offsets some of the cost of expanding cash transfers. Combining the two scenarios still leads to a net increase in public spending that requires higher tax rates to finance. The ratio of direct taxes to GDP is 0.5 percentage points higher in the “Combined Scenario” than in the baseline (Table 5). While this may appear to be a relatively small increase, the Egyptian government already runs large recurrent fiscal deficits equal to about 9 percent of GDP. As such, it may not be possible to use all cost savings from food subsidy reforms to finance an expanded cash transfer program.

4.5 Fiscal deficits and longer-term growth impacts

We conclude this section by dropping the assumption that changes in public spending are matched by changes in direct taxes. Instead, we allow the fiscal deficit to adjust in response to food subsidy reforms or expanded cash transfers. Table 6 reports results for the “Complete Reform” and “Expanded Program” scenarios, but with direct tax rates fixed at baseline levels.⁵

⁵ For all scenarios in Table 6, there is no change in direct tax rates, but the ratio of direct tax revenues to GDP may change slightly due to changes in GDP.

Table 6. Model results with fiscal deficits adjusting, 2015-2022

	(1)	(2)	(3)	(4)
	Deviation from baseline in 2022 (%)			
	Baseline share or value in 2022	Complete reforms (food subsidies)	Expanded program (cash transfers)	Combined scenario
Real GDP market prices	100.0	0.29	-0.60	-0.28
Absorption	106.7	0.28	-0.59	-0.28
Private consumption	78.6	-0.97	0.84	-0.11
Poor households	10.6	-3.15	12.30	9.04
Nonpoor households	68.0	-0.63	-0.94	-1.54
Public consumption	12.3	-1.98	1.06	-0.92
Investment demand	15.8	8.26	-9.02	-0.59
Net exports	33.4	0.91	-1.37	-0.46
Real GDP factor cost	100.0	0.16	-0.52	-0.34
Agriculture	11.5	-1.29	0.74	-0.56
Industry	31.7	1.25	-1.83	-0.55
Services	56.9	-0.16	-0.05	-0.18
<i>of which agri-food system</i>	23.9	-2.04	0.65	-1.42
Real exchange rate	100.0	0.89	-0.84	0.01
Real food price index	100.0	1.88	0.00	1.87
Fiscal deficit/GDP	9.2	-1.85	2.15	0.22
Direct taxes/GDP (%)	5.6	-0.06	0.01	-0.05

Source: Egypt CGE model results.

Note: Poor population defined as those in the two bottom per capita consumption quintiles. The real exchange rate is the number of Egyptian Pounds per unit of a trade-weighted combination of foreign currency. Fiscal deficit is total revenues minus consumption and recurrent spending and net transfers prior to public investment spending.

In the “Complete Reform” scenario in column (2), the elimination of food subsidies still leads to higher food prices and lower total consumption for poor households. However, nonpoor households’ consumption now also falls. In the previous version of this scenario, the government used the cost savings from subsidy reforms to reduce direct taxes. It now allows the fiscal deficit as a share of GDP to decline (by 1.9 percentage points). This increases the supply of loanable funds (savings), leading to much higher investment demand, which translates into faster capital accumulation and total GDP growth, especially in the industrial sectors linked to investment, such as machinery and construction. Thus, while total absorption grows faster when the deficit can adjust, it is now driven by higher investment spending rather than private consumption.⁶ This leaves nonpoor households worse off after the reforms, despite the faster pace of economic growth.

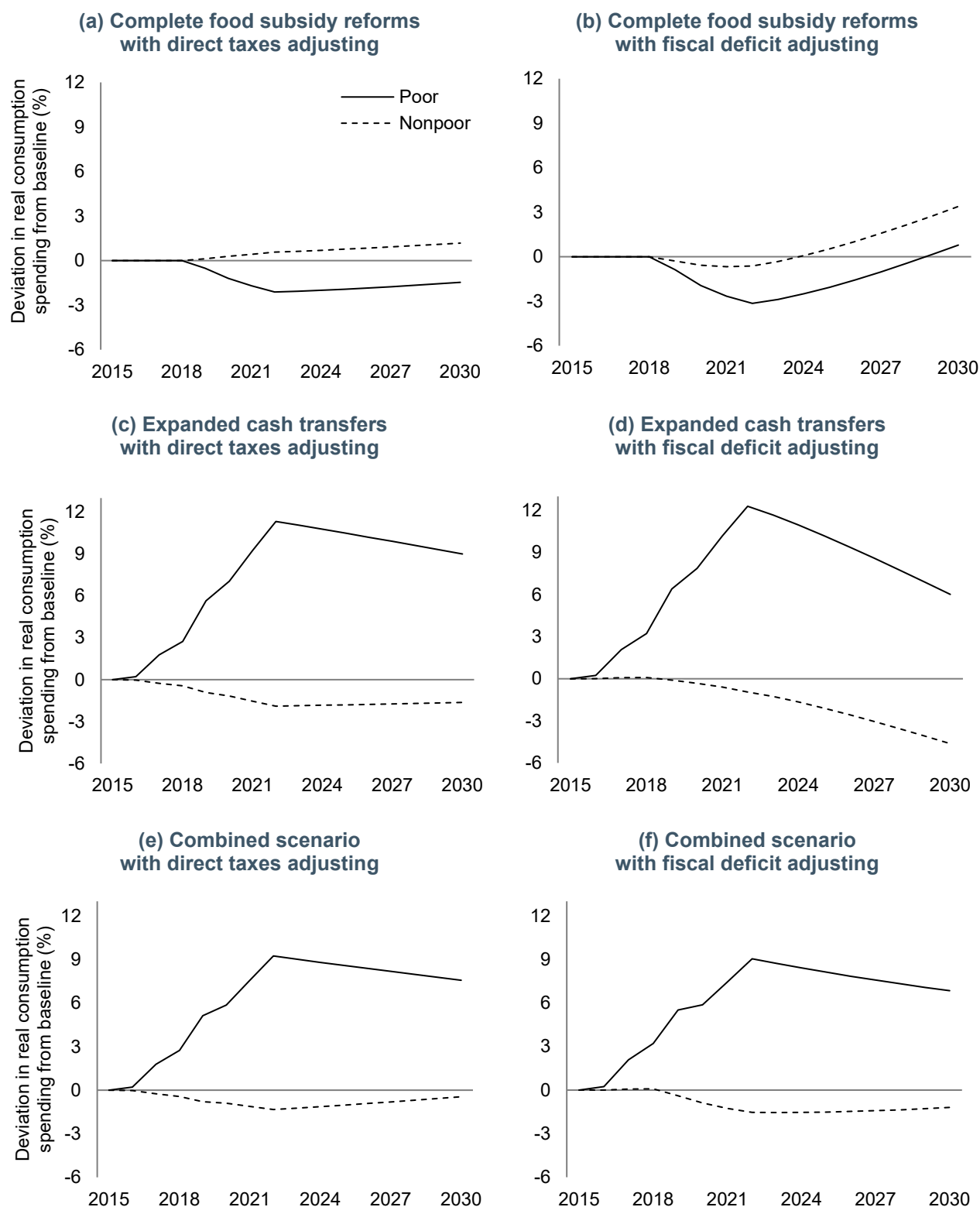
In the “Expanded Program” scenario in column (3) of Table 6, providing cash transfers to all poor households still leads to large consumption gains for the poor, but consumption losses for nonpoor households are now smaller. This is because the government now borrows to finance the cash transfer program, rather than increasing direct taxes. Total consumption for all households rises, which was not the case when cash transfers were financed by taxes. However, higher government borrowing redirects savings to recurrent spending, rather than investment, which now declines substantially. Lower investment demand leads to slower total GDP growth as the pace of capital accumulation decelerates. The contraction of the economy causes total absorption to fall, despite higher consumer spending.

The “Combined Scenario” in column (4) suggests that the faster growth from eliminating food subsidies is not enough to offset the slower growth caused by expanding cash transfers. Poor households are better off in 2022 when cash transfers replace food subsidies, especially

⁶ Total absorption is the sum of private and public consumption and investment spending. It is a measure of national welfare.

households in the lowest quintile (Figure 1). However, the rest of the economy is worse off, including households in the top expenditure quintile. Again, it is households in the middle of the income distribution that experience the largest welfare declines. Our dynamic model reveals the difficult trade-offs between consumption and economic growth and between improving the welfare of low-income households versus middle-income households.

Figure 2. Annual welfare results for poor and nonpoor households by social protection reform scenario and by tax rates versus fiscal deficit adjustments, 2015-2030



Source: Egypt CGE model results.

Figure 2 reports long-run welfare outcomes for poor and nonpoor household groups. Panels (a) and (b) reports results from the “Complete Reforms” scenario for the food subsidy program with direct taxes and the fiscal deficit adjusting, respectively. Reducing direct taxes in panel (a) leads to slightly faster economic growth, but not enough to alleviate the decline on poor households’ consumption by 2030. In contrast, the larger short-term consumption losses for both poor and nonpoor households in panel (b) are eventually more than offset by the faster economic growth that occurs when smaller fiscal deficits lead to higher investment.

The opposite is true in panels (c) and (d), which show the “Expanded Program” scenario for cash transfers under the two financing assumptions. Raising taxes to finance cash transfers for poor households in panel (c) leads to a small, but persistent, decline in consumption amongst nonpoor households. However, the large deceleration in economic growth in panel (d), caused by government borrowing, leads to larger welfare losses for nonpoor households over time (and smaller welfare gains for poor households).

Finally, panels (e) and (f) show results from the Combined Scenario of social protection reform. When the elimination of food subsidies is accompanied by an expansion of cash transfers, the welfare gains for poor households persist for longer, even under deficit financing. Moreover, welfare losses amongst nonpoor households are small and do not deteriorate over time. How social protection programs are financed has major implications for short-term distributional outcomes and long-term sustainability.

5 CONCLUSION

Egypt is gradually reforming its social protection system by improving the efficiency and targeting of Tamween food subsidies and by expanding cash transfers to poor households through Takaful and Karama. Both programs are expensive, raising concerns about their fiscal implications and long-term sustainability. However, the macroeconomic implications of financing large-scale programs are not well addressed in the social protection literature. Moreover, studies that do consider fiscal concerns usually focus on short-term outcomes, rather than longer-term growth and sustainability. Given the latter’s particular importance for Egypt, we have used a dynamic general equilibrium model to jointly evaluate the growth and distributional impacts of reforming the Tamween system and expanding the coverage and improving the targeting of TKP.

Our analysis suggests that eliminating food subsidies has significant adverse impacts on the welfare of the poor unless any such reforms are specifically targeted at nonpoor households. The latter is possible in Egypt, given that three-quarters of nonpoor households are beneficiaries of the food subsidy system, and nonpoor households receive about two-thirds of the total value of food subsidies. Importantly, our analysis suggests that the welfare of poor households would be enhanced by a smaller, but better targeted Tamween system. Moreover, if the cost savings from reforms are channeled into higher investment, then the longer-term growth benefits would eventually outweigh short-term welfare losses.

The welfare gains from cash transfers targeted at poor households are confirmed by our analysis. Consistent with recent survey-based evaluations, we find that cash transfers substantially improve the welfare of poor households. However, if TKP is financed by higher deficits, then the resulting deceleration of economic growth will gradually reduce welfare gains for the poor and lead to substantial welfare losses for the nonpoor, especially for middle-income households. Our analysis suggests that combining an expanded cash transfer program with targeted reforms to the food subsidy system would lead to the largest welfare gains for poor households, while leaving the welfare of nonpoor households largely intact.

Beyond Egypt, our analysis underscores the importance of considering both the distributional and fiscal implications of social protection programs, especially in developing countries, where public resources are scarce and opportunity costs are high. Our analysis benefitted from recent impact evaluations and reviews of Tamween and TKP, which allowed us to replicate the targeting and scale of both programs. However, based on the evidence available, we assumed that food subsidies and cash transfers do not improve the productivity of beneficiary households or workers. Further analysis is needed to determine if beneficiaries are more likely to, for example, invest in capital goods for home businesses or the education of household members. The resulting productivity gains could alleviate some of the adverse growth effects from financing social protection programs and lead to even larger and sustained welfare gains for poor households. This is particularly important for the long-term sustainability of social protection in Egypt.

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APPENDIX

Table A1: Model indices, parameters, and variables

Indices			
c	Commodities and activities	h	Representative households
f	Factors (land, labor and capital)	t	Time periods
Exogenous parameters (Greek characters)			
α^p	Production function shift parameter	θ^v	Value-added share of gross output
α^q	Import function shift parameter	π	Foreign savings growth rate
α^t	Export function shift parameter	ρ^p	Production function substitution elasticity
β	Household marginal budget share	ρ^q	Import function substitution elasticity
γ	Non-monetary consumption quantity	ρ^t	Export function substitution elasticity
δ^p	Production function share parameter	σ	Rate of technical change
δ^q	Import function share parameter	τ	Foreign consumption growth rate
δ^t	Export function share parameter	ν	Capital depreciation rate
ε	Land and labor supply growth rate	φ	Population growth rate
θ^i	Intermediate share of gross output	ω	Factor income distribution shares
Exogenous parameters (Latin characters)			
ca	Intermediate input coefficients	pwm	World import price
cab	Current account balance	qfs	Total factor supply
cd	Domestic transaction cost coefficients	$qgov$	Base government consumption quantity
ce	Export transaction cost coefficients	$qinv$	Base investment demand quantity
ci	Capital price index weights	rf	Factor foreign remittance rate
cm	Import transaction cost coefficients	sh	Marginal propensity to save
cpi	Consumer price index	tf	Factor direct tax rate
cw	Consumer price index weights	th	Personal direct tax rate
ga	Government consumption adjustment factor	tm	Import tariff rate
gh	Per capita transfer from government	tq	Sales tax rate
pop	Household population	ts	Household specific sales tax rate
pwe	World export price	wh	Net transfer from rest of world
Endogenous variables			
AR	Average capital rental rate	QG	Government consumption quantity
FS	Fiscal surplus (deficit)	QH	Household consumption quantity
IA	Investment demand adjustment factor	QI	Investment demand quantity
PA	Activity output price	QK	New capital stock quantity
PD	Domestic supply price with margin	QM	Import quantity
PE	Export price	QN	Aggregate intermediate input quantity
PM	Import price	QQ	Composite supply quantity
PN	Aggregate intermediate input price	QT	Transaction cost demand quantity
PQ	Composite supply price	QV	Composite value-added quantity
PS	Domestic supply price without margin	WD	Sector distortion in factor return
PV	Composite value-added price	WF	Economywide factor return
QA	Activity output quantity	YF	Total factor income
QD	Domestic supply quantity	YG	Total government revenues
QE	Export quantity	YH	Total household income
QF	Factor demand quantity	X	Exchange rate

Source: Egypt CGE model, adapted from Diao and Thurlow (2012)

Table A2: Model equations

Prices	
$PM_{ct} = pwm_c \cdot (1 + tm_c) \cdot X + \sum_{c'} PQ_{c't} \cdot cm_{c'c}$	1
$PE_{ct} = pwe_c \cdot X_t - \sum_{c'} PQ_{c't} \cdot ce_{c'c}$	2
$PD_{ct} = PS_{ct} + \sum_{c'} PQ_{c't} \cdot cd_{c'c}$	3
$PQ_{ct} \cdot (1 - tq_c) \cdot QQ_{ct} = PD_{ct} \cdot QD_{ct} + PM_{ct} \cdot QM_{ct}$	4
$PX_{ct} \cdot QX_{ct} = PS_{ct} \cdot QD_{ct} + PE_{ct} \cdot QE_{ct}$	5
$PN_{ct} = \sum_{c'} PQ_{c't} \cdot ca_{c'c}$	6
$PA_{ct} \cdot QA_{ct} = PV_{ct} \cdot QV_{ct} + PN_{ct} \cdot QN_{ct}$	7
$cpi = \sum_{ch} cw_{ch} \cdot PQ_{ct} \cdot (1 + ts_{cht})$	8
Production and trade	
$QV_{ct} = \alpha_c^p \cdot \sum_f (\delta_{fc}^p \cdot QF_{fct}^{-\rho_c^p})^{-1/\rho_c^p}$	9
$WF_{ft} \cdot WD_{fct} = PV_{ct} \cdot QV_{ct} \cdot \sum_{f'} (\delta_{f'c}^p \cdot QF_{f'ct}^{-\rho_c^p})^{-1} \cdot \delta_c^p \cdot QF_{fct}^{-\rho_c^p-1}$	10
$QN_{ct} = \theta_c^i \cdot QA_{ct}$	11
$QV_{ct} = \theta_c^v \cdot QA_{ct}$	12
$QA_{ct} = \alpha_c^t \cdot (\delta_c^t \cdot QE_{ct}^{\rho_c^t} + (1 - \delta_c^t) \cdot QD_{ct}^{\rho_c^t})^{1/\rho_c^t}$	13
$\frac{QE_{ct}}{QD_{ct}} = \left(\frac{PE_{ct}}{PS_{ct}} \cdot \frac{(1 - \delta_c^t)}{\delta_c^t} \right)^{1/(\rho_c^t-1)}$	14
$QQ_{ct} = \alpha_c^q \cdot (\delta_c^q \cdot QM_{ct}^{-\rho_c^q} + (1 - \delta_c^q) \cdot QD_{ct}^{-\rho_c^q})^{-1/\rho_c^q}$	16
$\frac{QM_{ct}}{QD_{ct}} = \left(\frac{PD_{ct}}{PM_{ct}} \cdot \frac{(1 - \delta_c^q)}{\delta_c^q} \right)^{1/(1+\rho_c^q)}$	17
$QT_{ct} = \sum_{c'} (cd_{cc'} \cdot QD_{c't} + cm_{cc'} \cdot QM_{c't} + ce_{cc'} \cdot QE_{c't})$	18
Incomes and expenditures	
$YF_{ft} = \sum_c WF_{ft} \cdot WD_{fct} \cdot QF_{fct}$	19
$YH_{ht} = \sum_f \omega_{hf} \cdot (1 - tf_f) \cdot (1 - rf_f) \cdot YF_{ft} + gh_h \cdot pop_{ht} \cdot cpi + wh_h \cdot X$	20
$PQ_{ct} \cdot (1 + ts_{cht}) \cdot QH_{cht} = PQ_{ct} \cdot (1 + ts_{cht}) \cdot \gamma_{ch} + \beta_{ch} \cdot \left((1 - sh_h) \cdot (1 - th_h) \cdot YH_{ht} \cdot pop_{ht}^{-1} - \sum_{c'} PQ_{c't} \cdot (1 + ts_{cht}) \cdot \gamma_{c'h} \right)$	21
$QI_{ct} = IA_t \cdot qinv_c$	22
$QG_{ct} = ga_t \cdot qgov_c$	23
$YG_t = \sum_h th_h \cdot YH_{ht} + \sum_f tf_f \cdot YF_{ft} + \sum_c (tm_c \cdot pwm_c \cdot QM_{ct} \cdot X + tq_c \cdot PQ_{ct} \cdot QQ_{ct}) + \sum_{ch} ts_{cht} \cdot Qh_{ct} \cdot pop_{ht}$	24

Equilibrium conditions	
$qfs_{ft} = \sum_c QF_{fct}$	25
$QQ_{ct} = \sum_{c'} ca_{cc'} \cdot QN_{c't} + \sum_h QH_{cht} \cdot pop_{ht} + QG_{ct} + QI_{ct} + QT_{ct}$	26
$\sum_c pwm_c \cdot QM_{ct} + \sum_f (1 - tff_f) \cdot rff_f \cdot YF_{ft} \cdot X_t^{-1} = \sum_c pwe_c \cdot QE_{ct} + \sum_h wh_h + cab_t$	27
$YG_t = \sum_c PQ_{ct} \cdot QG_{ct} + \sum_h gh_h \cdot pop_{ht} \cdot cpi + FS_t$	28
$\sum_h sh_h \cdot (1 - th_h) \cdot YH_{ht} + FS_t + cab_t \cdot X_t = \sum_c PQ_{ct} \cdot QI_{ct}$	29
Capital accumulation and allocation	
$AR_{ft} = \frac{YF_{ft}}{qfs_{ft}}$	30
$QK_{fct} \cdot \left(\sum_{c'} PQ_{c't} \cdot ci_{c'} \right) = \left(\frac{QF_{fct}}{qfs_{ft}} \cdot \frac{WF_{ft} \cdot WD_{fct}}{AR_{ft}} \right) \cdot \left(\sum_{c'} PQ_{c't} \cdot QI_{c't} \right)$	31
$QF_{fct+1} = QF_{fct} \cdot (1 - v) + QK_{fct}$	32
Land and labor supply, technical change, population growth, and other dynamic updates	
$qfs_{ft+1} = qfs_{ft} \cdot (1 + \varepsilon_f)$	33
$\alpha_{ct+1}^p = \alpha_{ct}^p \cdot (1 + \sigma_c)$	34
$pop_{ht+1} = pop_{ht} \cdot (1 + \varphi_h)$	35
$ga_{t+1} = ga_t \cdot (1 + \tau)$	36
$cab_{t+1} = cab_t \cdot (1 + \pi)$	37

Source: Egypt CGE model, adapted from Diao and Thurlow (2012)

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