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DEVELOPMENT STRATEGY AND GOVERNANCE DIVISION

September 2006

DSGD Discussion Paper No. 41

A Multi-level Analysis of Public Spending, Growth and Poverty Reduction in Egypt

Shenggen Fan, Perrihan Al-Riffai, Moataz El-Said,
Bingxin Yu, and Ahmed Kamaly

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ABSTRACT

The overarching objective of this report is to use a multi-level analysis approach to assess the effects of various government spending on growth and poverty reduction and their trade-offs between these two goals and to offer future policy options to achieve the Millennium Development Goals (MDGs). The study involves analyses and simulations at the different levels: household, sector/region as well as macro levels. Different analytical tools are used at the different levels. Analyses at the different levels are initially executed independently, but final synergy is drawn through an integrated macro-micro framework. This new approach has enabled us to gain new knowledge as well as new policy insights.

The study confirmed previous studies that universal subsidy is inefficient and usually achieves its intended goal at a much higher cost. Targeted approach is much preferred. If a well-targeted program is designed, more poverty reduction and much better income distribution can be obtained. Moreover, saved government resources can be used for productive investments in human capitals, infrastructure, and agricultural technology that would have long terms impact on growth and poverty reduction. Among all types of targeted programs, direct income transfer deserves a special attention. Aged, women, children and rural population are also special groups for targeting as they account for the majority of poor.

In order to achieve the maximized growth and poverty reduction impact, public investment needs to be better prioritized. Investing in human capital and infrastructure, particularly in rural Egypt, offers the highest return in terms of both growth and poverty reduction. This is conformed by all levels of analyses: household, regional and macro levels: In terms of regional priorities, investment in Upper Egypt would lead to largest poverty reduction as poor are increasingly concentrated in the region.

Investing in agriculture is potentially pro-poor and can contribute to long term national food security and economic growth. But the current trade policy that isolates domestic market from the international one leads to lower returns to these investments,

particularly in terms of rural income and rural poverty reduction. Most of the benefits from agricultural investment under an autarky economy are reaped by urban consumers and majority of rural population may suffer and they account for majority for Egyptian poor population. In summary, investing in agriculture and in rural areas is a must to lift rural poor out of poverty, but free trade in agriculture is a pre-condition for this to happen.

A MULTI-LEVEL ANALYSIS OF PUBLIC SPENDING, GROWTH, AND POVERTY REDUCTION IN EGYPT

Shenggen Fan, Perrihan Al-Riffai, Moataz El-Said, Bingxin Yu, and Ahmed Kamaly [1]

I. INTRODUCTION

Egypt is a lower middle-income country with a per capita gross domestic product (GDP) in 2003 of US$3,949 measured in international dollars, or purchasing power parity (World Bank 2005a). In the decade from 1975 to 1985, Egypt enjoyed rapid economic growth; however, with the collapse of oil prices after 1986, Egypt faced a period of economic slowdown. Mounting poverty, unemployment, and significant macroeconomic imbalances led to the adoption of economic reform programs. Following these reforms, the Egyptian economy showed signs of steady improvement: from, 1994 to 2004, GDP growth averaged 4.6 percent per year (World Bank 2005b). Nevertheless, poverty remains a serious problem in Egypt today. About 16 percent of the Egyptian population was poor in 2000, mostly in the rural sector. Moreover, Egypt still lags behind many middle-income countries in key social indicators. Further reforms are necessary to reduce poverty, especially if Egypt is to achieve the United Nations' Millennium Development Goal (MDG) of halving the number of poor between 1990 and 2015.

Government expenditures are an important means of promoting economic growth, reducing poverty, and improving income distribution. As Egypt pursues macroeconomic adjustments in relation to its limited—even declining—public resources, it is critical to analyze the relative contributions of various expenditures to growth and poverty reduction in order to gain valuable insights for improving allocative efficiency. Hence, the overarching objective of this report is to use a multi-level analysis approach to assess both the effects of various government expenditures on growth and poverty reduction and

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[1] Shenggen Fan is the Division Director; Perrihan Al-Riffai is a Collaborator; Moataz El-Said is a former Research Analyst; Bingxin Yu is a Research Analyst; and Ahmed Kamaly is a Collaborator of IFPRI's Development Strategy and Governance Division.

the trade-offs between these two goals in order to determine policy options toward the achievement of the MDGs. The study involves analyses and simulations at household, sectoral, and regional levels, and at macro-levels using alternative analytical tools. While the analyses at each level were carried out independently, the report provides a synergy of the findings.

In the next section, a review of economic and agricultural growth trends, as well as poverty trends, is provided for Egypt. Section 3 discusses trends in public expenditure allocation among economic sectors, while Section 4 models the effects of public spending on household incomes and overall poverty as additional spending increases household access to infrastructure, technology, and human capital. This analysis is carried out at the household level using integrated household budget surveys conducted by IFPRI in 1997. Similarly, Section 5 estimates the effects of public spending on growth and poverty using governorate-level data, and Section 6 adopts a macro-level approach to simulate the effects of reforming government spending and its allocation among economic sectors on growth and poverty, focusing on how Egypt can achieve the primary MDG of halving poverty. The report concludes with a synthesis of the different levels of analysis.

II. GROWTH AND POVERTY IN EGYPT

This section offers a brief review of Egypt's economy, its agricultural sector, and its poverty trends. Associated changes in institutions and policies are also highlighted to provide an analytical foundation for evaluating the impact of public investments on growth and poverty reduction.

Economic Growth

Egypt's economy has undergone significant transformation in the four decades since 1965. During the 1960s and early 1970s, Egypt followed an inward-looking economic strategy that completely relied on the domestic market, reflecting extreme skepticism of private foreign investment. GDP grew by 3.24 percent per year from 1965 to 1974 (Table 1). In 1974, an official "open door" policy was initiated, marking a shift toward greater integration into the world economy. Egypt gradually liberalized foreign trade, attracted more private foreign investment, and became more open to modern technology. As a result of these reforms, and with the oil sector booming, GDP grew at an impressive rate of 8 percent per annum between 1975 and 1985 (Table 1).

Table 1. Economic and Agricultural Growth in Egypt

Year	GDP	AgGDP	GDP per capita	Ag GDP per worker
	Million of 1995 constant US$		International dollars per person, 1995 prices	
1965	13,398	4,382	1,199	618
1970	15,785	4,684	1,273	617
1975	18,731	5,622	1,385	702
1980	29,896	6,302	2,020	743
1985	41,410	7,232	2,480	885
1990	50,915	8,263	2,723	1,091
1995	60,159	9,452	2,785	1,182
2001	80,093	12,177	3,129	1,447
Annual growth rate (percent)				
1965–74	3.24	2.63	1.27	1.38
1975–84	7.99	2.78	5.78	2.39
1985–94	3.85	2.68	1.26	3.12
1995–2001	5.06	4.02	2.13	3.14
1965–2001	5.56	2.84	3.20	2.61

Sources: GDP and Agricultural GDP are from the World Bank (2003). Population and economically active agricultural population data used to calculate GDP per capita and AgGDP per worker are from FAO (2002).

In the mid-1980s, however, Egypt suffered from the crash in oil prices. Economic performance slowed, and GDP grew at the slower rate of 3.8 percent per year from 1985 to 1994. The inflation rate was high, and the total debt service accounted for over 20 percent of exports and about 7 percent of gross national income (GNI). In response, the country embarked on a structural adjustment program in the early 1990s, with the result that inflation slowly reduced and markets became exposed to greater competition (El-Laithy, Lokshin, and Banerji 2003). Since the mid-1990s, Egypt experienced rapid economic growth, with GDP increasing by an annual rate of 4.6 percent per annum between 1994 and 2004.

Agriculture

Like many low middle-income countries, the reliance of the Egyptian economy on agriculture declined over the past three decades, from about 30 percent of GDP in 1970 to 16 percent in 2004. The agricultural sector, however, remains important to the economy because it provides employment to 33 percent of the country's labor force.

Covering only 3 percent of the country's total land area, agriculture in Egypt is essentially focused in the Nile Valley and the Delta region. The mild climate, assured water supply, and fertile soil provide Egyptian farmers with one of the most productive agricultural systems. Nevertheless, Egypt is highly dependent on imports for its food supply due to the relative scarcity of arable land and water resources, high population growth, relatively low investments in agricultural development, and insufficient funding for agricultural research and development. One of the prominent characteristics of Egypt's agricultural sector is the dominance of small-scale farmers (Esfahani 1987; Faris 1995).

Agricultural GDP (AgGDP) grew at a sustained rate of 2.7 percent per year throughout the mid-1960s until the mid-1990s, and accelerated at 3.3 percent per year after 1994 (Table 1). According to Nassar and Mansour (2003), a combination of institutional reform and technological progress (improved irrigation, drainage, fertilizers, and crop varieties) contributed to this sustained growth. Policy changes have also taken place, as the sector eventually moved from inward-looking policies, until 1986, to more liberalized approaches aimed at opening the agricultural sector to increase production and productivity. Some of the most important reforms were the gradual removal of governmental crop prices, the elimination of input subsidies, the reduction of tariffs and other protection measures, and the liberalization of the land tenure system (Nassar and Mansour 2003; Shousha and Pautsch 1997).

Poverty

In formulating poverty reduction strategies, poverty trends are an essential input. To examine Egyptian poverty trends over time, this report relies on estimates published in two studies. Adams (1985) assessed rural poverty in Egypt between 1958/59 and 1982 based on consumer budget surveys. Adams (2003) analyzed changes in rural, urban, and total poverty during the 1980s and 1990s using the results from national household budget surveys. In both papers, the author measured poverty by estimating the percentage of population living below the poverty line, which was defined as the level of expenditures needed to meet minimum food and nonfood requirements. Although the estimates from these two studies are not directly comparable due to differences in sample size, methodology, and expenditure level benchmark, they provide some indication of changes in poverty over time.

One noticeable trend is the large regional variance that marks poverty in Egypt. Poverty is worst in upper Egypt (Table 2).[2] More than 20 percent of the population is poor in seven of the nine governorates located in the upper Egypt region in 1999/2000. In contrast, poverty is lowest in the metropolitan region where only 5.1 percent of households are poor, constituting only 4 percent of the country's poor. Between 1995/96 and 1999/2000, the incidence of poverty declined by more than half in the metropolitan region, but it increased significantly in the upper Egypt region. In the frontier and in lower Egypt regions, urban poverty declined in the 1990s, whereas rural poverty

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[2] These poverty estimates are based on the household income, expenditures, and consumption surveys conducted by the Central Agency for Public Mobilization and Statistics of Egypt (CAPMAS) in 1995/96 and 1999/2000. The data are reported in World Bank (2002b).

increased. In addition to these regional variations, Datt, Jolliffe, and Sharma (2001) further characterize the poor based on a 1997 household survey data, which reveals that the poor in Egypt tend to come from large, female-headed households that depend on agriculture and trade services for their livelihood.

Table 2. Poverty Incidence in Egypt by Governorates, Headcount Index

Region	1995/96			1999/2000		
	Urban	Rural	All Egypt	Urban	Rural	All Egypt
Metropolitan region						
Cairo	9.42		9.42	5.01		5.01
Alexandria	23.15		23.15	6.24		6.24
Port Said				0.90		0.90
Suez	6.45		6.45	1.91		1.91
Lower Egypt						
Damietta	3.74	11.53	9.10	0.25		0.07
Dakahlia	1.57	10.90	8.67	7.79	17.55	14.88
Sharkia	10.5	17.83	16.55	9.12	13.71	12.70
Qaliubia	0.57	34.11	26.14	6.05	9.09	7.94
KafrEl-Sheikh	4.55	18.74	16.27	3.77	5.90	5.42
Gharbia	2.75	10.26	8.17	4.51	7.84	6.85
Menufia	20.00	26.68	25.48	9.81	21.12	18.96
Beheira	13.81	37.59	33.12	6.16	8.36	7.85
Ismailia	2.03	8.01	4.93	0.90	11.12	6.02
Upper Egypt						
Giza	3.42	5.49	4.34	9.43	16.97	12.89
Beni-Suef	17.44	32.97	29.57	32.35	51.66	47.26
Fayoum	6.56	32.10	27.22	19.76	34.27	31.18
Menia	14.71	27.58	25.64	9.12	24.03	21.41
Assiut	22.79	51.96	44.78	39.21	56.76	52.08
Sohag	17.98	26.79	24.87	35.61	41.09	39.88
Qena	14.22	33.65	29.52	13.3	24.85	22.46
Aswan	9.73	9.97	9.89	18.33	18.81	18.61
Louxor	n.a.	n.a.	n.a.	25.35	34.8	29.20
Frontier region						
Red Sea		4.96	2.46	7.52	12.22	9.52
El Wadi El-Gedid	3.83	4.55	4.13	4.85	10.94	7.36
Matrouh	2.90		1.40	5.43	26.21	14.13
North Sinai	15.05	43.52	29.55		36.49	16.17
South Sinai	n.a.	n.a.	n.a.		2.70	1.16
Total	11.02	24.8	19.41	9.21	22.07	16.74

Source: World Bank (2002b, Table A2.4a and b).
Notes: n.a. indicates data were not available. In 1995/96, North Sinai includes poverty incidence estimates for South Sinai.

III. PUBLIC EXPENDITURES: TRENDS AND COMPOSITION

Egypt's public spending is an important instrument for achieving economic growth and equity goals. Public spending includes long-term investment on R&D, education, infrastructure, and social spending.

Public Investment and Provision

Agriculture

Public spending in agriculture increased from $1.82 billion (international dollars at 1995 prices) in 1980 to $3.32 billion in 1998, or an average growth rate of 3.4 percent per year over the period (Table 3). However, underlying this growth rate is a period of

Table 3. Public Expenditure in Egypt

Year	Total	Capital	Agriculture	Defense	Education	Health	Social security & welfare	Transportation & communications
International dollars (billions at 1995 prices)								
1980	41.78	8.95	1.82	3.72	3.03	0.87	3.49	0.42
1981	39.29	7.76	1.96	5.32	3.36	0.88	4.76	0.53
1982	52.87	10.25	1.95	6.73	4.87	1.27	5.89	0.89
1983	47.14	6.56	2.21	7.39	5.03	1.34	5.81	0.91
1984	50.61	6.95	2.2	9.29	5.31	1.31	6.14	1.02
1985	51.92	7.14	2.2	9.68	5.86	1.35	6.01	1.17
1986	54.06	7.69	2.21	9.54	5.91	1.27	5.87	1.63
1987	42.49	7.24	1.77	8.27	5.11	1.05	4.71	1.58
1988	46.6	7.42	2	6.63	5.46	1.13	6.03	1.85
1989	41.69	6.62	2.04	5.28	5.58	1.16	5	1.03
1990	39.36	6.81	1.86	4.52	5.51	1.11	5.07	1.13
1991	45.65	7.82	1.91	5.07	6.13	1.26	5.11	1.2
1992	58.69	18.26	2.21	4.84	6.07	1.24	5.33	1.4
1993	54.87	10.31	2.32	4.79	6.76	1.34	6.02	1.65
1994	59.69	11.42	2.58	4.87	7.64	1.41	7.14	2.02
1995	56.3	10.84	2.47	5.14	7.79	1.41	7.46	2.4
1996	56.93	12.41	2.57	5.32	8.07	1.59	2.53	2.33
1997	56.74	13.64	2.99	5.35	8.38	1.87	2.67	2.58
1998	58.9	14.16	3.32	5.36	9.52	2.12	2.44	3.05
Annual growth rate (percent)								
1980–89	–0.02	–3.30	1.28	3.97	7.02	3.25	4.08	10.48
1990–98	5.17	9.58	7.51	2.15	7.07	8.42	–8.74	13.21
1980–98	1.93	2.58	3.40	2.05	6.57	5.07	–1.97	11.64

Source: Total expenditures and capital expenditures are from World Bank (2000); all other data are from IMF (various years).

stagnation in the 1980s, when agricultural expenditure growth averaged 1.3 percent, followed by a period of accelerated growth at 7.5 percent per year in the 1990s. Public spending followed a similar trend, declining as a share of AgGDP during the 1980s and increasing in the 1990s.

Historically, public investment in Egyptian agriculture (in addition to agricultural research) has been geared mainly toward the provision of irrigation and drainage. Today, the Agricultural Research Center (ARC), under the Ministry of Agriculture, is the most important research organization in Egypt. It comprises 16 research institutes, 6 central laboratories, and 46 agricultural research stations and employs more than 2,500 PhD researchers (ARC 2004). Academic institutions in Egypt also play a role in agricultural research. The country's higher education sector includes 16 faculties of agriculture and 8 faculties of veterinary medicine.

Health

In the past several decades, health status and conditions have improved in Egypt. Life expectancy has increased from 45 years in 1960 to 68 years in 2001, and the percentage of under 12-year-old children immunized for measles grew from 41 percent in 1980 to 97 percent in 2001. Further, infant mortality per 1,000 births declined from 189 to 35 between 1960 and 2001 (World Bank 2003).

Public health expenditures increased from $0.87 billion (international dollars in 1995 prices) in 1980 to $2.12 billion in 1998, representing average yearly growth of 5.07 percent (Table 3). Despite the fiscal austerity imposed by the structural reforms, health expenditures increased sharply during the 1990s, at an average rate of 8.42 percent per year. Nevertheless, health accounted for only 3.6 percent of total public expenditures in 1998; defense, by comparison, represented nearly 10 percent.

A larger share of Egypt's health care is privately financed. In 2000, public health expenditures represented 1.75 percent of GDP, whereas the corresponding share for private health expenditures was 2.05 percent (World Bank 2003). Thus, total health expenditure represents 3.80 percent of GDP.

Education

Education expenditures grew at 6.57 percent per year from 1980 to 1998. However, public spending on education as a percentage of GDP is about 1 percent lower than averages for other low middle-income countries. During the early 1990s, increasing the supply of education was emphasized; between 1992 and 1996, the number of classrooms rose by 53 percent across Egypt, and by 1997 nearly all of Egypt's villages had access to primary schools (El Saharty, Richardson, and Chase 2005). Until the mid-1990s, there was a significant and unchallenged gender bias in schooling and education in Egypt. In order to address this problem, and in an attempt to improve the overall quality of education, the Egyptian government initiated the Basic Education Enhancement Program. As a result, female literacy rose by 10 percent from 57 in 1992 and to 67 percent in 2002, and among the 15–24 year old age group illiteracy fell by 10 percent, from 28 percent in 1990 to 18 percent a decade later. While these figures still fall short of documented objectives, they are still considered a significant advancement in narrowing the gender gap in education (UNDP 2004).[3]

Infrastructure

Public expenditures on transportation and communications grew significantly, from 0.4 billion dollars in 1980 to 3.1 billion in 1998, representing average annual growth of 11.64 percent (Table 3). While across Egypt there is no difference in access to electricity for the poor or nonpoor, there does seem to be a gap in the availability of piped water and the connection to public sewerage, and rural areas have the lowest access to these two services (World Bank 2002a). Within that regional discrepancy, poor people

[3] While there remain large regional gender gaps in education in general, in rural upper Egypt over a five year period between 1996/97 and 2001/02, the national gender gap in primary education fell by half, from 7 percent to 3.5 percent. Discrepancies in the male/female literacy rates, however, had not been eliminated as of 2002; while female literacy rates varied across sources that year, about half the female population was illiterate compared with only 29 percent of the male population (El Saharty, Richardson, and Chase 2005).

are even more disadvantaged, and despite improvements in the late 1990s, figures still show a bias against the poor and rural inhabitants.

A rapidly growing population continues to pose a daunting challenge for Egypt in further developing its infrastructure, particularly its water systems. Given that 70 percent of poor people reside in rural areas, increasing water use efficiency could result in substantive increase in on- and off-farm income and employment. With water services accounting for 10 percent of the government's total public expenditures, reforming water management has become a critical factor in accelerating the country's economic growth. To address this problem, the Ministry of Water Resources and Irrigation has launched a water management reform agenda in collaboration with major donors. In May 2005, the World Bank approved a $120 million loan for an Integrated Irrigation Improvement and Management Project, which has a target of increasing water productivity by 15 percent and increasing farm-related income for the 380,000 families in the project area, at least two-thirds of whom are living on less than $2 a day (World Bank 2005a).

Spending on Social Safety Nets

Subsidies have existed in Egypt since World War II, when food rations and price ceilings were established on staples for low income groups. Subsidies on major consumer items such as sugar, coarse cotton fabric, kerosene, edible oil, and tea were introduced and never removed (MacDonald 1983). Starting the 1960s, housing, transportation, education, and other social service subsidies were introduced. By the beginning of the 1980s, the subsidy bill had reached it highest level. Torn between maintaining the subsidy program for social equity and a rapidly ballooning fiscal deficit, President Mubarak and his cabinet realized that reducing the subsidy bill was a necessity (Alderman, and von Braun 1984). By the turn of the century, the government was successful in constricting the subsidy program to include only four food items—*baladi* bread, *baladi* flour, cooking oil, and sugar.[4] More recently, the subsidy program was

[4] Baladi Bread refers to the state subsidiezed Egyptian bread.

expanded to include rice, pasta, tea, fava beans, margarine, and lentils[5] (Morrow 2004). As a result, the subsidy bill is expected to reach L.E. 6.5 billion in 2005, almost double its 2004 level (Morrow 2004).[6]

Despite the universal agreement that social safety nets play a prominent role in alleviating poverty, it has also been acknowledged that the effectiveness of these programs depends on appropriate targeting. Shortcomings, such as inclusion and exclusion errors, high administrative costs, and widespread operational inefficiencies, have led to the introduction of a crossbreed of safety nets. This type of reform seeks to break poverty cycles by alleviating transitory and chronic/intergenerational poverty through monetary disbursements conditional on education and health improvements.[7]

The Egyptian government has acknowledged the necessity of reforming subsidies as far back as the mid-1970s. At that time, due to Egypt's mounting external debt, a standby agreement with the International Monetary Fund was struck, and reforms in the subsidy system were implemented. The consequences were the infamous 1977 food riots that have continued to act as a political straitjacket on food price reform in Egypt. Since the time of the riots, any food price reform initiatives have had to take into account political, economic, and social ramifications.

Two types of safety net programs are currently in use in Egypt: development programs and welfare programs. Development programs refer to the Social Fund for Development (SFD), which is supported by the government (World Bank 2005a). Originating in the early 1990s, it is considered the main social safety net instrument for the government. However, despite its more than 14 years of operation, the SFD's impact on poverty alleviation in Egypt has yet to be determined. Welfare programs refer to the

[5] Reversal in subsidy allocations is a common side effect of gradual reform of the subsidy structure (Gupta et al. 2000).

[6] As of 2005 the subsidy bill had ballooned to around 9 percent of GDP even though more than half of it stemmed from fixed domestic petroleum prices.

[7] An often-cited example of such a program is Mexico's PROGRESA. Initiated in 1997, it initially targeted only Mexico's rural poor but by 1999 had reached 40 percent of the rural poor (Coady and Harris 2004). PROGRESA provides cash transfers, family health care, and nutritional supplements to the poor; however, benefits are tied to children's school attendance. To date, improvement in child nutrition, school attendance, and school drop out rates have been marked (Al Riffai 2004).

provision of subsidies on a multitude of private (food, electricity, and fuel) and public (health and education) goods. The subsidies are classified as implicit subsidies (revenue lost by the government for the provision of certain goods and services at below market prices to the consumer)[8] and explicit subsidies in the form of cash and commodity subsidies. For the purpose of this study, we focus on the consumer food subsidy program—the largest component of all explicit subsidies in the Egyptian economy.

[8] The Government of Egypt provides implicit subsidies on energy products.

IV. HOUSEHOLD-LEVEL ANALYSIS

In this section, the 1997 *Egypt Integrated Household Survey (EIHS)* conducted by IFPRI is used to link household income and poverty status to their endowments in human and physical capitals and their access to infrastructure, health services, and agricultural technology. The household-level analysis follows the framework used in the Tanzania study by Fan, Nyange, and Rao (2003), which provides an opportunity to apply and adapt existing methods to the Middle East and North Africa (MENA) region.

Model

To model the impact of infrastructure access, education, and health on the welfare of households, we estimate three separate equations: income, expenditure, and poverty determination. Since many households in Egypt engage in both agricultural and nonagricultural activities, it may be difficult to separate income sources between these two activities. On the one hand, even in urban areas, a substantial share of household income often comes from agriculture. On the other hand, nonagricultural activity has gradually become an increasingly important source of income for rural residents (about two-thirds of total income). Therefore, total income, rather than agricultural income, is used in our estimation to reflect the full picture of the household welfare.

Household income for a typical household depends on agricultural production assets; household characteristics, such as household members' age, sex, and education level; and characteristics of the community in which the household is situated.

$$TOTALIPP = f\,(HA, HC, CC, Z), \tag{1}$$

where *TOTALIPP* is total income per capita; *HA* is a set of household production assets used for agricultural production; *HC* is a set of household characteristics, like education and telephone access; and *CC* is a set of community characteristics, including public facilities availability at the community level. The variable *Z* represents other factors that are not included in the equations, such as regional agroclimatic conditions and social and economic policies. Since these variables are not easy to quantify, regional dummy variables are used to control for the effects of such variables.

Similar to total income, household expenditure is also determined by household production assets, household characteristics, and community characteristics.

$$EXPPP = f\,(HA, HC, CC, Z), \tag{2}$$

where *EXPPP* is total expenditure per capita. Whether a particular household is above or below the poverty line is defined based on household per capita expenditure. As described above, the poverty line is defined using either per capita total expenditure or per capita food expenditure. In turn, how much a household can spend depends, to a large extent, on how much the household can earn. Therefore, poverty can be modeled in terms of per capita income.

$$\begin{aligned} POVERTY &= F(TOTALIPP) \text{ or} \\ &= F(AGRIIN, NAGRIIN). \end{aligned} \tag{3}$$

Through equations (1) and (3), we can link a household's poverty status to household assets and characteristics, and community characteristics by estimated income equations (both agricultural and nonagricultural). For example, the impact of certain community characteristics, say distance to public transport (DISPT), can be derived as

$$\begin{aligned} &\partial POVERTY/\partial AGRIIIN\ (\partial AGRIIN/\partial DISPT) + \partial POVERTY/\partial NAGRIIIN \\ &\quad (\partial NAGRIIN/\partial DISPT. \end{aligned} \tag{4}$$

However, we can also model poverty directly as a function of *HA*, *HC*, and *CC*:

$$POVERTY = F\,(HA, HC, CC, Z). \tag{5}$$

This is the so-called reduced form of the poverty determination. Since poverty is a binary variable at the household level, the ordinary least squares (OLS) estimation will result in biased estimates. Therefore, a Probit model is used to estimate the poverty determination equation:

$$Prob\ (POVERTY{=}1) = F\,(\beta' X), \tag{6}$$

$$Prob\ (POVERTY{=}0) = 1 - F\,(\beta' X). \tag{7}$$

Here βs are the parameters to be estimated. However, as for any other nonlinear regression model, the parameters are not the marginal effects of the variables on the right-hand side (Greene 1999). If we assume F (.) is normally distributed, the marginal effect is

$$\partial E[POVERTY]/\partial X=\Phi((\beta' X)\beta, \tag{8}$$

where $\Phi(.)$ is the standard normal density. STATA (A statistical and econometric software developed by StataCorp) gives the marginal effects of each independent variable through the command of DPROBIT. This will both avoid the OLS bias and allow us to calculate the marginal effects of the independent variables directly.

Model Specification

As pointed out by Datt and Jolliffe (1999), before discussing which variables should be included among the set of explanatory variables, it is helpful to consider the issue of potential heterogeneity of the models of income and expenditure—that is, whether we expect the models to be different across regions. While there can be different levels of heterogeneity, the metropolitan and urban regions are sufficiently different from the rural regions in the Egyptian context, and the upper and lower rural regions could differ as well. Therefore, it is feasible to use different models for each region. For instance, it could be argued that public investment has different returns in rural and urban areas and hence has different implications for income and expenditure patterns in different stratum.

Another practical reason for distinguishing separate models for the five regions is that, while we can make use of a number of community-level variables available for the rural areas (lower rural and upper rural), such variables are unavailable for the metropolitan and urban strata because the complete community module was not conducted in urban areas. Thus, when we estimate the model without community variables, we separate the whole sample into five regions: metropolitan, upper rural, upper urban, lower rural, and lower urban. But when we include community variables in our model, we only estimate equations for two regions: upper rural and lower rural.

In selecting potential determinants of living standards, a key consideration is the choice of variables that are exogenous to current income or expenditure levels. Fan, Nyange, and Rao (2003) proposed the selection of potential determinants including education attainment, health status of household members, and access to telecommunications and transportation. These variables either depend on earlier household income levels, or they are recorded at the community-level and are therefore exogenous to the household. Hence, the selected variables can be broadly grouped as either household- or community-level variables.

Household-level variables include a set of demographic variables, and others related to household assets, educational attainment, and the distance to roads and telecommunications. The demographic variables included are the age of the household head, the ratio of dependents to income-earners, and two binary variables for the gender and marital status of the household head. Household assets are measured as the area of cultivated land owned and the value of livestock. In the education category, the variable is the number of years of schooling completed by household head. The infrastructure variables are access to electricity (subsequently dropped due to its insignificance, since 95 percent or more of sample households had access to electricity) and access to a telephone. Another variable, the time normally needed to reach the nearest paved road by foot, is also included as a measure of access to public infrastructure. Two binary variables for the usage of fertilizer and improved seed (also subsequently dropped due to its high correlation with fertilizer usage [over 0.8 in most strata]) are used as proxies for technology.

At the community level, a set of dummy variables related to the availability of a range of public facilities or services, including post office, public telephone, bus stop, paved road, dirt road, local shop, market center, grain/oil mill, agricultural extension office, agricultural cooperative, commercial bank, village bank, primary school, preparatory school, high school, health service, hospital, clinic, private pharmacy, private doctor, visit from an agricultural extension worker and veterinarian, public canal, community canal, private canal, and tube well. Although there are no significant correlations among these variables, it is both confusing and infeasible to include all of them in the model and would result in severe multicollinearity. With the help of statistical testing, we chose the following variables for the final specification: whether the community has a post office (*postoffice),* a commercial bank service *(commbank),* a market *(market),* a primary school *(prepschool),* a bus stop *(busstop),* access to paved roads *(pavedroad),* access to extension service *(agextn),* a clinic *(clinic),* access to a public canal *(pubcanal),* and access to a private canal (*privcanal)*. Other variables are not included because the null hypothesis of zero effects could not be rejected.

There may also be some concerns of potential bias in parameter estimates due to endogeneity or omitted variables. For instance, it could be argued that agroecological factors that determine the productivity of land are omitted from the regression and hence are implicitly included in the error term of the model. If these factors are a significant determinant of income or expenditure, the mean of error term will not converge to zero in probability limit, and the parameter estimates for the included explanatory variables will be inconsistent. A variant of this problem is the argument that some of the determinants themselves depend on some omitted variables. For instance, whether there is a market in the village may depend on the omitted agroecological factors. Because the omitted factors are subsumed by the error term, these determinants are now correlated with the error term and hence give rise to inconsistent parameter estimates. One solution to the potential problem of omitted variables is the use of a fixed-effects model. Thus, a fixed effect at the governorate-level is introduced. There are 20 governorates in our sample. A governorate fixed-effect model views the governorate as distinct, not only in terms of its entities, administrations, and institutions, but also in terms of its natural resource endowments (agroclimatic conditions, soil fertility, and so on).

Data Description

The primary data used in this report are from the *Egypt Integrated Household Survey* (EIHS), a multi-topic, nationally representative household survey carried out by the International Food Policy Research Institute (IFPRI) in collaboration with Egypt's Ministry of Agriculture and Land Reclamation (MALR) and Ministry of Trade and Supply (MOTS). Fieldwork began in the first week of March 1997 and concluded in the third week of May 1997.

The questionnaire was administered to 2,500 households from 20 governorates using a two-stage, stratified selection process. In the first stage, 125 primary sampling units (PSU) were randomly selected with probability proportional to size. The second stage of the process entailed randomly selecting 20 households from each PSU. The advantage of a two-stage process over a pure random selection process is that it dramatically reduces the scope of fieldwork and therefore reduces the cost of the survey. The disadvantage is that standard errors resulting from two-stage samples tend to be significantly larger than those resulting from pure random samples. Details on this questionnaire are available in the EIHS 1997 documentation (Datt and Jolliffe 1999).

The design of the survey also stratified selection based on the five regions of Egypt already discussed: the metropolitan, lower urban, lower rural, upper urban, and upper rural regions. This classification for Egypt has often been used in the tabulation of data from the Household Income and Expenditure Surveys conducted by the Central Agency for Public Mobilization and Statistics (CAPMAS). It has also been commonly deployed in the literature on poverty in Egypt (see, for instance, El-Laithy and Osman 1996; Korayen 1994; and Ali et al. 1994).

The survey questionnaire consisted of 18 sections on a series of topics that integrated monetary and nonmonetary measures of household welfare and a variety of household behavioral characteristics. Both household- and community-level data are included. The household data include responses from male and female household questionnaires, while the community data include overall characteristics of the community/villages within which the surveyed households are situated. The variables used in our model are defined and explained below.

1. *agipp*. Agricultural income per capita (in Egyptian pounds) measures yearly income per person from agricultural products or agricultural activities, calculated as the sum of market value of homegrown products consumed within household and income from crop, livestock, and livestock product sales. Market value of homegrown products includes food that the household has grown and received from other sources over the past seven days, which is converted to yearly consumption. Income from crop sales is the total value for both sales and remaining crops produced in the past agricultural year. Livestock and livestock product sales are calculated from Section 13 of the female questionnaire. Livestock sales is the total for all animals in the past 12 months. Livestock product sales includes milk, butter, eggs, cheese, or animals slaughtered for sale, home consumption, or use as gifts over the past 12 months.

2. *nonagipp.* Nonagricultural income per capita (in Egyptian pounds) measures yearly income per person derived from nonagricultural activities. It includes rental income (for dwellings, land, and other assets), short-term wage income, long-term salary income, miscellaneous agricultural activity income, enterprise income, remittance and transfer income, and other income.

Dwelling rental is the monthly amount the household received for renting part of the dwelling unit, converted to yearly rental income. Information on wage income for casual or temporary labor is obtained from the wage employment section for all persons 10 years or older and is the product of three components: average daily wage and noncash benefits, average working days per month, and average working months during the past 12 months. Salary income is the sum of take-home pay and bonuses, tips, incentives, and allowances over past 12 months, minus contributions to an employee providence fund. Land rental income includes all cash and in-kind payments received for renting any owned land over the past agricultural year. Miscellaneous agricultural revenues include incomes both from selling crop by-products (straw, husk, and so on) and from renting draft animals, tractors, threshers, other machineries, and other miscellaneous income over the past agricultural year. Income from enterprise activities is computed as the share of net revenues over past 12 months that is kept by the household. Income from asset rentals is the amount received by renting any real assets or by renting land or property neither cultivated nor lived in by the household over the past 12 months.

3. *totalipp.* Total income per capita (in Egyptian pounds) is the yearly sum of agricultural and nonagricultural income per person.

4. *exppp*. The measure of total yearly expenditure per capita (in Egyptian pounds) is taken from the research of Datt, Jolliffe, and Sharma (2001) and Datt and Jolliffe (1999), which is quite extensive and draws on responses from several sections of the household survey. Total expenditure is the sum of total food consumption (including tobacco and alcohol); total nonfood, nondurable good expenses; estimated use value of durable goods; and an actual or imputed rental value of housing. This monthly total expenditure is converted to yearly expenses for consistency.

Estimated Results

Table 4 presents the estimated total income per capita determination equations, controlling for the fixed effect at the governorate level. The estimated results show that the dependent ratio affects per capita household income significantly. The more dependents or the less income earners a household has, the lower household income per capita tends to be. Gender or marital status of a household head is not a significant factor affecting household income. The coefficient of household head marital status is marginally significant at the 10 percent level. Age of household head is found to be significant in the lower urban and lower rural regions. The educational attainment of the household head contributed most significantly to per capita household income, and the coefficients are significant in all strata. Access to a telephone is also an important influence on income improvement in urban areas. The coefficients of improved seed usage are statistically significant and of the expected sign in both the upper and lower rural strata, implying that improved policy with a focus on new seed availability could substantially boost rural income.

Table 4. Estimated Results of Total Income and Expenditures Equations

Equation	Metropolitan		Lower Urban		Lower Rural		Upper Urban		Upper Rural	
	coefficient	***t*-value**	**coefficient**	***t*-value**	**coefficient**	***t*-value**	**coefficient**	***t*-value**	**coefficient**	***t*-value**
Income per capita, lgtotipp										
	Observations = 322		Observations = 349		Observations = 647		Observations = 357		Observations = 630	
	R^2 = 0.1810		R^2 = 0.2841		R^2 = 0.3117		R^2 = 0.3886		R^2 = 0.2737	
landpp					0.02	3.88			0.03	2.09
lglvskvalue					0.04	3.73			0.05	4.57
hhhsex	0.23	1.16	0.18	0.73	–0.13	–1.00	–0.10	–0.49	–0.24	–2.22
hhhmarr	–0.28	–1.46	–0.45	–1.90	0.11	0.90	–0.17	–0.89	–0.12	–1.04
hhhedu	0.03	3.71	0.06	4.28	0.04	6.75	0.04	4.20	0.04	6.13
hhhage	0.00	1.42	0.01	2.68	0.01	3.09	0.01	3.32	0.01	2.25
dependratio	–0.09	–4.00	–0.18	–5.20	–0.12	–7.27	–0.18	–6.35	–0.09	–6.56
telephone	0.30	3.33	0.26	1.58	0.08	0.87	0.41	3.85	0.12	0.83
improvedseed					0.49	5.99			0.52	6.54
walkroad	–0.37	–0.42	–1.18	–1.34	–0.27	–0.81	–0.39	–0.57	0.19	1.05
constant	6.63	20.23	6.09	14.91	5.87	28.94	6.54	21.20	5.39	20.75
Expenditure per capita, lgexpp										
	Observations = 321		Observations = 346		Observations = 636		Observations = 355		Observations = 624	
	R^2 = 0.3122		R^2 = 0.3968		R^2 = 0.3135		R^2 = 0.4373		R^2 = 0.2938	
landpp					0.00	0.40			0.02	1.81
lglvskvalue					0.02	3.08			0.02	3.29
hhhsex	0.04	0.33	0.16	1.20	–0.21	–2.44	–0.10	–0.76	0.01	0.18
hhhmarr	–0.07	–0.57	–0.33	–2.29	0.15	1.77	–0.17	–1.38	–0.01	–0.18
hhhedu	0.04	5.52	0.04	5.95	0.04	9.70	0.03	5.35	0.03	7.30
hhhage	0.00	0.39	0.01	2.34	0.01	5.18	0.00	1.56	0.00	1.97
dependratio	–0.09	–5.12	–0.09	–5.51	–0.07	–6.66	–0.05	–3.77	–0.05	–5.28
telephone	0.22	3.01	0.35	5.02	0.31	4.93	0.42	6.08	0.33	3.78
improvedseed					–0.04	–0.76			0.00	–0.01
walkroad	–0.81	–1.24	–0.53	–1.44	–0.26	–1.50	–1.63	–3.72	–0.06	–0.44
constant	7.90	28.66	7.00	29.77	6.91	47.53	7.85	40.11	6.84	47.51

Estimated results of per capita household expenditure are also summarized in Table 4. Education of household head, dependent ratio, and telephone access are found to be significant and positively correlated with per capita expenditure. Consistent with Datt and Jolliffe (1999), we found that educational attainment and reducing the number of unemployed household members are the main beneficial effects of policy changes.

Table 5 provides estimated results from the reduced form Probit model for poverty status. Again, education, dependent ratio, and telephone availability are revealed as determinants of household poverty status.

As previously mentioned, community characteristics could be well exploited when rural sectors only were considered. Similar to the case of strata, the educational attainment of the household head and the dependent ratio are universally related to total income, expenditure, and poverty status in both lower and upper rural Egypt (Table 6). In general, the community characteristics do not provide significant welfare effects on expenditure or poverty, except for the existence of preschool, paved roads in lower rural areas. In lower rural Egypt, infrastructure—such as a post office, bus stop, and access to an agricultural extension worker—help residents to increase their total incomes, while (public and commercial) canal service decreases incomes. Some of the community-level variables may have a high correlation with household access to public services such as distance to paved roads, access to a telephone, and the use of modern seeds.

The household-level analysis provides information on how household and community characteristics correlate with household income and poverty status. But there are several disadvantages. It is difficult, for example, to control for endogeniety and multicollinearity problems unless there is a long time series of household panel data. In addition, household-level analysis cannot capture the market-, regional-, and macro-level effects resulting from various government interventions. Finally, it is difficult to link improved public provisions to meaningful government investment programs. Therefore, regional- and macro-level analyses are required to complement the household-level analysis.

Table 5. Estimated Results of the Poverty Equation, the Reduced Form

Variable	Metropolitan coefficient	Metropolitan z-value	Lower Urban coefficient	Lower Urban z-value	Lower Rural coefficient	Lower Rural z-value	Upper Urban coefficient	Upper Urban z-value	Upper Rural coefficient	Upper Rural z-value
	Observations = 320		Observations = 327		Observations = 636		Observations = 349		Observations = 624	
	Pseudo R^2 = 0.2270		Pseudo R^2 = 0.2244		Pseudo R^2 = 0.2207		Pseudo R^2 = 0.3345		Pseudo R^2 = 0.1888	
landpp					–0.07	–1.99			–0.14	–3.85
lglvskvalue					–0.07	–3.25			–0.05	–2.57
hhhsex	–0.40	–0.95	–0.55	–1.74	0.34	1.32	0.42	0.98	–0.13	–0.66
hhhmarr	0.21	0.48	0.40	1.19	–0.27	–1.14	0.04	0.12	–0.10	–0.49
hhhedu	–0.09	–3.87	–0.10	–4.74	–0.11	–6.52	–0.08	–3.67	–0.06	–4.13
hhhage	0.00	–0.33	–0.01	–1.22	–0.02	–3.28	0.00	–0.02	0.00	–0.18
dependratio	0.16	2.97	0.19	3.43	0.01	0.07	0.09	2.01	0.08	0.47
telephone	–0.61	–2.58	–0.66	–2.02	0.14	4.60	–1.46	–3.14	0.10	3.97
improvedseed					–1.40	–2.91			–1.04	–2.96
walkroad	1.97	0.95	1.47	1.26	0.23	0.38	0.95	0.55	–0.28	–0.85
constant	–0.56	–0.72	–1.07	–1.63	0.33	0.80	–0.61	–0.83	–0.72	–1.75

Table 6. Estimates of Total Income Per Capita, Total Expenditure Per Capita, and Poverty Status with Community Variables

	lgtotipp				lgexppp				poor			
	Lower Rural		Upper Rural		Lower Rural		Upper Rural		Lower Rural		Upper Rural	
Variable	**coefficient**	***t*-value**	**coefficient**	***t*-value**	**coefficient**	***t*-value**	**coefficient**	***t*-value**	**coefficient**	***t*-value**	**coefficient**	***t*-value**
	Observations = 416		Observations = 503		Observations = 406		Observations = 499		Observations = 406		Observations = 499	
	R^2 = 0.3868		R^2 = 0.3147		R^2 = 0.2961		R^2 =0.3111		Pseudo R^2 = 0.2748		Pseudo R^2 = 0.2229	
landpp	0.03	3.07	0.02	1.77	0.01	1.08	0.01	1.56	–0.13	–1.78	–0.14	–3.67
lglvskvalue	0.05	3.64	0.05	4.50	0.01	1.39	0.03	3.03	–0.08	–2.36	–0.07	–3.01
hhhsex	–0.04	–0.24	–0.22	–1.76	–0.18	–1.61	0.06	0.75	0.16	0.46	–0.09	–0.39
hhhmarr	0.02	0.12	–0.20	–1.50	0.13	1.19	–0.09	–1.07	–0.17	–0.53	0.04	0.15
hhhedu	0.04	5.65	0.04	4.46	0.03	6.63	0.03	5.65	–0.09	–4.00	–0.07	–3.68
hhhage	0.01	2.43	0.01	2.06	0.01	3.22	0.00	1.48	–0.02	–2.35	0.00	–0.50
dependratio	–0.13	–6.86	–0.08	–5.57	–0.06	–4.33	–0.05	–4.84	0.13	3.09	0.11	3.57
telephone	0.05	0.45	0.27	1.93	0.22	3.07	0.37	3.78	–1.21	–2.85	–1.06	–2.76
improvedseed	0.40	4.47	0.49	5.84	0.09	1.64	–0.01	–0.19	–0.28	–1.11	0.17	0.90
walkroad	–0.73	–1.81	0.11	0.61	0.09	0.46	–0.09	–0.60	–0.91	–0.90	–0.28	–0.74
postoffice	0.37	2.47	–0.06	–0.29	0.01	0.12	0.09	0.59	0.02	0.06	–0.01	–0.02
commbank	–0.19	–0.67	–0.27	–1.19	0.23	1.26	0.19	1.04	–0.20	–0.27	–0.74	–1.44
market	0.26	1.35	–0.48	–1.99	0.14	1.07	–0.04	–0.33	–0.56	–1.04	–0.93	–1.96
prepschool	–0.83	–3.51			–0.38	–2.96			1.62	2.93		
busstop	0.39	2.48	0.16	0.93	0.09	0.97	0.13	1.11	–0.63	–1.84	–0.13	–0.39
pavedroad			–0.28	–1.64			–0.19	–2.07			0.36	1.22
agextn	0.30	1.72	–0.13	–0.71	0.15	1.28	–0.06	–0.48	–0.40	–0.87	0.26	0.77
clinic	0.27	1.50	0.00	–0.03	–0.13	–1.16	–0.02	–0.20	0.10	0.23	–0.18	–0.72
pubcanal	–0.68	–2.46	0.23	1.04	0.05	0.35	0.09	0.59	–0.03	–0.04	–0.14	–0.33
commcanal	–0.56	–2.62	0.06	0.42	–0.24	–1.81	–0.10	–1.22	0.68	1.14	0.29	1.18
constant	6.90	21.56	6.30	13.66	7.39	20.88	6.80	22.21	0.21	0.23	–1.39	–1.56

Note: Pavedroad and prepschool are dropped due to collinearity.

V. REGIONAL LEVEL ANALYSIS

This section of the report evaluates the impact of various government investments on agricultural growth and poverty reduction using data from different governorates for the period 1980–2000. This level of analysis captures some of the effects that the household- level analysis cannot capture, such as effects on labor and product markets.

The Model

Public investment affects rural poverty through many channels. It directly increases farmer incomes by increasing agricultural productivity, which in turn reduces rural poverty. Indirect impacts include higher agricultural wages and improved nonfarm employment opportunities. In addition to its productivity impact, public investment directly promotes rural wages, nonfarm employment, and migration, thereby reducing rural poverty.

Public investments in rural sectors not only contribute to growth, employment, and wages in rural areas, but also help the development of the national economy by providing labor, human and physical capital, cheaper food, and markets for urban industrial and service development. Growth in the national economy reduces poverty in both rural and urban sectors. In an era of macroeconomic reforms, understanding these different effects provides useful policy insights to improve targeting efficiencies, budgeting, and ultimately the effectiveness of government poverty reduction strategies.

Few studies have linked poverty reduction to the driving forces behind economic growth and income distribution. The determination of rural poverty adds a greater complexity. Rural residents draw their income from multiple sources. Farm activities are still major sources of income for many rural residents, but nonfarm activities such as rural industry and services have increasingly become important. Another important income source is seasonal migration and employment in the urban sector. Building on earlier work on India (Fan, Hazell, and Thorat 1999), rural poverty determination is modeled as follows:

$$P = f(LP, RWAGE, NFE). \qquad (9)$$

Equation (9) models the determinants of rural poverty (*P*), which is defined as the percentage of the rural population living below the poverty line. They include agricultural labor productivity (*LP*), nonagricultural employment (*NFE*), and rural wages (*RWAGE*).

Equation (10) models the agricultural labor productivity function. The dependent variable is the gross value of agricultural production per agricultural worker in the agricultural sector (*LP*). The independent variables are a set of technology, infrastructure, and education variables used to capture their impact on labor productivity growth. These variables include agricultural research stock variables constructed from past government expenditures on agricultural research and development (RDS), irrigated areas (*IRRIA*) per agricultural worker, the illiteracy rate of the rural population (*ILIT*), the length of rural roads per agricultural worker (*ROADS*), and the number of rural telephones per agricultural worker (*PHONE*).

$$LP = f(RDS, IRRIA, ILIT, ROADS, PHONE). \tag{10}$$

Equations (11) and (12) are wage and nonfarm employment determination functions. Rural nonfarm wages and employment are determined by developments in infrastructure, improved education, and growth in agricultural productivity. Growth in agricultural productivity is included to model the linkage between growth in the agricultural sector and nonfarm employment and rural wages.

$$RWAGE = f(LP, ROADS, PHONE, ILIT). \tag{11}$$

$$NFE = f(LP, ROADS, PHONE, ILIT). \tag{12}$$

The marginal impact of public capital expenditures on poverty can be derived from this system of equations by taking the total derivatives, as follows, using agricultural research and rural education as examples:

$$\begin{aligned} dP/dRDS = {} & (\partial P/\partial LP)(\partial LP/\partial RDS) \\ & +(\partial P/\partial NFE)(\partial NFE/\partial LP)(\partial LP/\partial RDS) \\ & +(\partial P/\partial RWAGE)(\partial RWAGE/\partial LP)(\partial LP/\partial RDS), \end{aligned} \tag{13}$$

$$
\begin{aligned}
dP/dILIT = {} & (\partial P/\partial LP)(\partial LP/\partial ILIT) \\
& +(\partial P/\partial NFE)(\partial NFE/\partial LP)(\partial LP/\partial ILIT) \\
& +(\partial P/\partial RWAGE)(\partial RWAGE/\partial LP)(\partial LP/\partial ILIT) \\
& +(\partial P/\partial NFE)(\partial NFE/\partial ILIT) \\
& +(\partial P/\partial RWAGE)(\partial RWAGE/\partial ILIT). \qquad (14)
\end{aligned}
$$

Equation (13) measures the marginal effect on poverty reduction of the research stock variable. It also decomposes the different pathways through which impacts occur (see Fan, Hazell, and Thorat 1999 for a more detailed discussion). The first term on the right-hand side is the direct poverty impact of growth in agriculture due to agricultural research and extension, while the remaining terms measure the effects of agricultural research and extension through improved nonfarm employment and wages.

Equation (14) is the marginal poverty reduction effect of improved education. Similar to equation (13), the first three terms on the right-hand side are poverty reduction effects of improved education both directly and indirectly through growth in agricultural production by improving nonfarm employment opportunities and rural nonfarm wages. The last two terms capture the poverty reduction impact by directly improving nonfarm employment and nonfarm wages.

To convert annual government expenditures on public capital into stocks in monetary terms, we use the following procedure:

$$K_t = I_t + (1-\delta)\mathrm{K}_{\mathrm{t-1}}. \qquad (15)$$

where K_t is the capital stock in year t, I_t is gross capital formation in year t, and δ is the depreciation rate (5 percent). To obtain initial values for the capital stock, we used a similar procedure to Kohli (1982):

$$K_0 = \frac{I_0}{(\delta + \mathrm{r})}. \qquad (16)$$

Equation (16) implies that the initial capital stock in year 0 (K_0) is capital investment in year 0 (I_0) divided by the sum of the real interest rate (r) and the depreciation rate. In the case of Egypt, we assume a real interest rate of 3 percent.

Sensitivity analyses were conducted to determine whether different depreciation rates and real interest rates would affect our final results. We found the impact of different real interest rates to be negligible. But different depreciate rates do result in some differences.[7] Nevertheless, the ranking of returns among different types of investment and across regions remains the same.

Obtaining stocks for various types of public investment enables the following regressions to be run to determine the relationship between these stocks, in monetary terms, and physical stocks:

$$P_{i,t}=f(K_{i,t}, Z_{i,t}), \tag{17}$$

where $P_{i,t}$ is physical stock of public investment, i, in year t—for example, road density, years of schooling, rural literacy rate, electricity consumption, or irrigated areas—and $K_{i,t}$ is capital stocks in monetary terms for investment i in year t constructed from equation (15). To control other factors that may be omitted from the equation ($Z_{i,t}$), both year and regional dummies are added during the estimation.

To calculate the marginal return, in terms of poverty reduction, of different types of government spending such as roads, education, and irrigation, we use derivatives of the following form, using education as an example:

$$dP_t/dK_{e,t} = dP_t/dILIT_t * \partial ILIT_t/\partial K_{e,t} . \tag{18}$$

Equation (18) implies that the marginal return to capital stock in education ($K_{e,t}$) is the product of the marginal return to improved literacy (derived in Equation (14)) and marginal impact of capital stock on the years of schooling.

[7] Sensitivity analyses of different interest and depreciation rates for roads were conducted for the following scenarios: (a) 3 percent real interest rate and 10 percent depreciation rate, (b) 5 percent real interest rate and 10 percent depreciate rate, (c) 3 percent real interest rate and 5 percent depreciation rate, and (d) 5 percent real interest rate and 5 percent depreciation rate. The estimated marginal returns were 0.86, 0.84, 0.61, and 0.63, respectively.

Data

Most of the data used in this study come from various agencies of the Egyptian government.

Poverty. The poverty variable is measured as the percentage of the rural population living below the poverty line.

Agricultural labor productivity. Agricultural labor productivity is measured as gross agricultural production value per agricultural worker.

Nonfarm employment. Rural nonfarm employment is measured as the percentage of the rural labor force engaged in nonfarm activities such as manufacturing, construction, trading, and services.

Wages. Rural wages are the average daily compensation for rural workers.

Agricultural research. Agricultural research in Egypt is conducted at the national level, but national research affects production throughout the country through spillover effects. Therefore, we include the same agricultural research stock variable constructed from past expenditures in all regions. When we calculate returns to agricultural research investment, we also add agricultural extension to determine total investment in agricultural R&D.

Infrastructure. Most of the infrastructure and education variables used in the model are defined in physical terms and data for suitable measures are available at the national and regional levels. The greatest difficulties arose in collecting data on government expenditure by type of investment and region, which are needed for calculating the value of the existing stocks of these investments and their unit costs. Like many countries, Egypt compiles data on public spending by different types of investments at the national level, but there is much less data on how these expenditures are allocated to different regions. Therefore, some techniques and assumptions had to be used to make these allocations.

Irrigation. Both irrigated areas and investment costs are available at the regional level.

Rural education. The illiteracy rate is used to proxy the improvement in education.

Roads. Road length and public expenditure data on roads are available by region from the government office.

Rural telephones. The number of telephones (that is, handsets) is used as a proxy for improved telecommunications.

Model Estimation

We use the double-log functional forms for all equations in the system. More flexible functional forms, such as translog or quadratic equations, impose fewer restrictions on the estimated parameters, but many coefficients are not statistically significant due to multicollinearity problems. Regional dummies are added to equations of poverty, productivity, employment, migration, and terms of trade to capture the fixed effects of regional differences in agroclimatic and socioeconomic factors. The time trend variable is also added to these equations, with the exception of the poverty equation, to control for any macroeconomic polices that have the same impact on every region. The model is estimated for the period 1981–2000.

There are two approaches in estimating an equation system: the single equation approach and the multiple equation (systems) approach. Single equation techniques, such as instrumental variable estimators, two-stage least squares, and limited information maximum likelihood are easy to estimate and require only limited information. However, the single equation technique often neglects information contained in the other equations of the system. For this reason, we use the full information maximum likelihood (*FIML*) estimation technique. Among all estimators, FIML is the most efficient. The only disadvantage is its estimation complexity but with the rapid development of econometric software, this task has become increasingly easier and more accessible.[8]

[8] SAS Version 8.0 for Windows was used in our estimation.

Rural poverty is negatively correlated with labor productivity, rural wages, and the level of nonfarm employment (Equation 1), but rural wages is not statistically significant (Table 7). The insignificance of rural wages on nonfarm employment is similar to the findings in many Asian countries (Thailand and Vietnam). This may indicate that there is an inelastic supply of rural labor or a large labor surplus in these economies. Rural nonfarm employment has the largest poverty reduction elasticity among all explanatory variables. The estimated agricultural labor productivity equation indicates that improvements in access to telephones and rural education has a large impact on labor productivity. In particular, a higher illiteracy rate is strongly correlated with lower labor productivity, with an elasticity of –1.16. The roads variable is also correlated with labor productivity but is not statistically significant. Equations (3) and (4) show that development in telecommunications (proxied by telephones) and improvements in education are statistically significant in promoting rural wages and nonfarm employment. Rural roads, however, are not statistically significant. Improved labor productivity is also not statistically significant in helping to increase rural wages and nonfarm employment.

Table 7. Estimated Results Using the Regional Level Data

(1)	*P*	=	–	*0.232 LP* *(–2.78)**	–	*0.109 RWAGE* *(–0.95)*	–	*1.068 NFE* *(–2.56)**		$R^2 = 0.303$
(2)	*LP*	=	+ +	*0.239 PHONE* *(2.21)** *0.247 RDS* *(2.13)**	+ +	*0.046 ROADS* *(1.56)* *0.254 IRRI* *(3.45)**	–	*1.62 ILIT* *(4.68)**		$R^2 = 0.298$
(3)	*RWAGE*	=	+ +	*0.054 PHONE* *(2.04)** *0.232 LP* *(1.56)*	+	*0.01 ROADS* *(0.00)*	+	*3.38 ILIT* *(6.49)**		$R^2 = 0.312$
(4)	*NFE*	=	– –	*0.151 PHONE* *(4.82)** *0.001 LP* *(–0.002)*	+	*0.017 ROADS* *(0.37)*	+	*3.38 ILIT* *(6.49)**		$R^2 = 0.833$

Note: Explanation of variable abbreviations found in text

Marginal Returns in Agricultural Growth

We first calculate the marginal returns in agricultural growth per additional physical unit. Then, using the parameters estimated through equations (9) through (12), we are able to calculate the unit cost of public capitals. Comparing the unit cost with the marginal benefit, we can easily estimate benefit–cost ratios (Table 8).

Table 8. Effects of Public Investment on Agricultural Growth

Region	Phone	Roads	Education	R&D	Irrigation
Benefit–cost ratio					
Metropolitan	0.25	0.31	n.a.		7.89
Lower Egypt	6.37	3.73	5.81		1.85
Upper Egypt	4.36	4.79	4.43		1.97
Egypt	3.13	2.84	4.86	4.12	1.94
Poverty reduction effect, number of poor per 1 million LE					
Metropolitan	17.31	21.19	9.98		545.16
Lower Egypt	129.68	75.97	59.15		37.56
Upper Egypt	335.27	368.40	170.53		151.42
Egypt	133.95	121.47	208.26	176.31	83.16

For telephones, the national average benefit–cost ratio is 3.13. However, in metropolitan area, the ratio is less than one, meaning that the return from investments in telephones does not cover the cost. For lower Egypt, the ratio is more than 6, which indicates that the returns from agricultural production are six times greater than its cost. If we include the effect on nonfarm GDP and rural GDP, the benefit–cost ratio would be much larger. Upper Egypt has a ratio of 4.36. The national average benefit–cost ratio of road investment is 2.84. Again, the benefit–cost ratio in the metropolitan area is less than one. The largest return is in upper Egypt, where the ratio is 4.8. Lower Egypt has a ratio of 3.7. Education investment has the highest return among all types of investment with a benefit–cost ratio of 4.8 nationally. Lower Egypt has the highest marginal return with a benefit–cost ratio of 5.8. Upper Egypt has a ratio of 4.4—75 percent of the effect in lower Egypt. Irrigation has the lowest benefit–cost ratio among all types of investments with a ratio of 1.94. It suggests that irrigation is still a good investment (note that this ratio is high compared with Asia).[9] Among all investment, at the national level, education ranks first, followed by agricultural R&D, telephones, roads, and irrigation. For lower Egypt, telephones and roads have high returns, followed by education and irrigation. For upper Egypt, roads rank first, followed by telephones and education, which have similar marginal returns. Similar to other regions, irrigation has the lowest returns.

Marginal Returns in Poverty Reduction

Similar to returns in agricultural growth, we calculate returns in poverty reduction in terms of both physical and monetary units (Table 8 presents the estimated number of poor reduced per thousand LE). At the national level, education has the largest impact per unit of investment. For every million LE investment, more than 200 poor people would be lifted above the poverty line. Agricultural research closely follows the education effect. The poverty reduction effect is 176 for every million LE invested. Two infrastructure variables, telephones and roads have similar poverty reduction effects per unit of spending. Irrigation investment has the smallest marginal impact on poverty reduction, and its effect is only 40 percent of the education effect and 47 percent of the R&D effect.

Large regional differences occur in the marginal effect of different investments. With the exception of irrigation, all kinds of investment have the largest impact in upper Egypt. Except for irrigation, all kinds of investment in Metropolitan area have the lowest marginal impact.

[9] In the case of India, the benefit–cost ratio of irrigation is less than one (Fan, Hazell, and Thorat 1999). For China, the ratio is marginally above one (Fan, Zhang, and Zhang 2002).

VI. MACRO-LEVEL ANALYSIS

The CGE model used in this report is a dynamic computable general equilibrium (CGE) model of the Egyptian economy used to quantify the effect of public spending on the promotion of pro-poor growth, equity, and poverty. The model follows Lofgren and Robinson (2004) and Al-Riffai, Lofgren, and El-Said (2005) in its explicit formulation of the potential channels through which different kinds of government spending influence productivity and economic performance. It is set to analyze alternative public policy spending scenarios and subsidy treatments in terms of their potential impact in promoting growth, poverty alleviation, and an equitable distribution of income. The model is solved simultaneously for all time periods. In the current version, however, the model's structure is dynamic recursive, such that it is composed of within-period and between-period modules. This dynamic-recursive nature of the model means that economic agents are treated as "myopic," making their decisions on the basis of current conditions.

What follows provides a description of the model, its extension to explicitly introduce price subsidies and cash transfers, as well as a presentation of the 1997 social accounting matrix (SAM) for Egypt. A discussion of the approach used to analyze the distribution and poverty implications is also included.

Model Structure

In a dynamic recursive CGE model, it is typical to follow a two-stage approach. In the first stage, a within-period static CGE model is solved for a new equilibrium, whereas, in the second stage, a between-period model provides the necessary linkages to update variables that drive growth in the static first stage.

Within-Period Module

The within-period module is a standard static CGE model.[9] The production technology is represented by a nested CES (constant elasticity of substitution) and Leontief (fixed-coefficient) functions. Domestic output in each sector is a CES function

[9] See Lofgren et al. 2002 for more information on the Static CGE model.

of value-added and an intermediate input aggregate. In turn, value-added is a CES function of primary factors, while intermediate input use is determined by sector specific fixed input–output coefficients multiplied by sectoral activity levels. Producers seek to maximize their profits yielding sector-specific factor demand. The model solves for long-run equilibrium in that all factors of production (agricultural labor, nonagricultural labor, capital, and land) are assumed to be sectorally mobile. Factor supplies are fixed for each product activity. Even though economywide wages adjust to clear factor markets, each activity pays an activity-specific wage rate that is the product of the economywide wage rate and a term that captures activity-specific wage "distortions" (or differentials).

The markets of goods and services are competitive: economic agents take all output prices as given. Each production sector is assumed to produce differentiated goods for the domestic and foreign (export) markets, allocating their goods between these two markets in a revenue-maximizing manner subject to imperfect transformability (captured by a CET [constant elasticity of transformation] functional specification).[11] For sales to foreign markets, the prices paid to producers depend on world prices, the exchange rate, transactions costs, and an export tax.

Similarly, domestic demanders differentiate between domestic products and imports. For each commodity, the composite commodity demanded is modeled as a CES aggregate of imports and domestic products. Domestic demanders minimize the cost of obtaining a given amount of this composite good. The price paid for imported goods depends on the world price, the exchange rate, import tariffs, and transaction costs (of moving the imported goods into the domestic market). The price of domestically produced goods used domestically is a function of the supplier price and transaction costs (of physically moving the good from the supplier to the demander). Such product differentiation permits two-way trade, gives some realistic autonomy to the domestic price system, and allows for a continuum of tradability and two-way trade, which is commonly observed even at very fine levels of disaggregation (de Melo and Robinson

[11] Transforming output allocation between domestic or foreign markets (exports).

1981). Households maximize a Stone–Geary utility function subject to a budget/spending constraint, yielding linear expenditure system (LES) demand functions. Household income is made up of factor income and transfers from the government. The typical household spends its income on commodity consumption, taxes (income, sales), and savings.

Government income is made up of direct and indirect taxes. The government spends this income on consumption, investment, and interest payments (domestic and foreign). Real government consumption and investment are exogenous and disaggregated by spending type into agriculture, human capital (education and health), infrastructure, social security, defense, and other spending.

The model follows the small-country assumption under which local consumers and producers face given world prices for exports and imports. For domestically produced goods, prices are flexible and market-clearing. The economy earns foreign exchange from exports, net transfers from abroad to domestic institutions, public foreign borrowing, foreign grants, and foreign direct investment (FDI). These foreign exchange earnings are spent on imports (of goods and services), interest payments on foreign and domestic debt, and repatriation of domestically earned profits of foreign investors (which depends on capital rents, and the share of the private capital stock owned by foreigners, in its turn a function of FDI. In this model, exports, imports, interest payments on all (foreign and domestic) debt and repatriation of foreign investors' profits are all endogenous. The rest of the items in the balance of payments are exogenous.

"Closure rules" or "system constraints" are constraints that have to be satisfied by the economic model but are not considered in the optimizing decision of any micro-agent (Robinson 1989). [13] These constraints include three macroeconomic balances (associated with the accounts for the government, the rest of the world, and savings–investments) and supply–demand balances in the product and factor markets. The "closure rules" of the model indicate the mechanisms on the basis of which the model satisfies these

[13] For a discussion on macro balances, see Lofgren et al. 2002*,* 13–17.

constraints. For these three macro-balances, receipts/revenue earned must equal spending from that account. According to the closures used in the simulations, for the government balance, flexible government savings ensure equality between government receipts and government spending. A flexible real exchange rate equilibrates foreign exchange earnings and receipts through its influence on exports and imports. In the savings/investment balance, the value of investments is determined by available savings—that is, investment is savings-driven.

Between-Period Module

The between period module in a dynamic recursive CGE model provides the changes in parameters and variables in the economy over successive periods. In this model, the stocks of production factors, population, and debts (domestic and foreign) change over time. The stocks of labor, land, and population are exogenous whereas, as noted above, capital stocks are endogenous along with total factor productivity (TFP). Debt stocks are endogenous: the stock of foreign borrowing in time period t+1 is a function of the stock of foreign borrowing in previous time periods and "new borrowing." The between-period module then passes the updated information to the within-period module allowing it to solve under an updated information set for the consecutive period. The model is solved in a single pass for the period 1997–2015. Given the dynamic-recursive structure, the solution values for each time period (year) represent an equilibrium for that year that depends on the current and past parameters and relationships, not the future. For each period, the model solution generates a rich set of economic indicators, ranging from national accounts to sectoral and household-level information. The baseline growth path is then used as a benchmark (counterfactual) for comparing the effect of a policy reform that generates a new growth path with a comparable set of results.

Poverty Module

In addition to the within-period and the between-period modules discussed above, a separate poverty module is used to compute the inequality and poverty indicators.[14] The poverty module follows a representative-household (RH) approach along the lines described in Lofgren et al. (2002). It is used at two different stages, once after the within-period module is solved for the baseline growth path, and once after every policy simulated growth path. Initially, the module generates benchmark inequality and poverty indicators for comparison with new ones generated when the module is used for the second time.

Using data from the within-period module on mean consumption and a consumer price index (CPI) for each household group, the poverty module computes a poverty line to replicate exogenous poverty rates. For the case of Egypt, rural and urban poverty rates using the head count index are obtained from the World Bank's Poverty Reduction Study (World Bank 2002a–c). In addition, the poverty module permits the user to choose between two approaches to the specification of the within-group distribution, a parametric approach based on a log-normal distribution and a nonparametric approach, which is directly based on household survey data.

Earlier examples of studies using the first approach include Adelman and Robinson (1978) and de Janvry, Sadoulet, and Fargeix (1991). In this case, a log-normal distribution is used to specify the distribution of income within each household group. According to this approach, only the first moment, the distribution mean, would shift to the right or left as a result of a policy change, while higher moments are fixed. Empirically, poverty and inequality indicators are generated from the overall distribution, which is generated by summing the within-group and between-group distributions.

The second approach offers a relatively straightforward method for linking the CGE model with a household survey data. Poverty and inequality indicators are

[14] Inequality and poverty indicators include Atkinson, Gini, and Theil inequality measures and the FGT poverty measures (P_0, P_1, P_2).

computed using a distribution from a sample of actual household consumption expenditures. Each household observation is mapped to one of the RH groups in the CGE model. In the case of the Egypt model, the observations are mapped to 10 household groups by quintiles for both rural and urban households to form a within-group distribution. When a new policy is introduced (for example, a change in the composition of public spending) relative prices and the pattern of each RH income and consumption expenditures are altered. Measuring the percentage change in a RH group consumption and applying the same rate of change to each household observation in the survey yields a new distribution following the new policy. Comparing the difference between a new set of poverty and income inequality indicators (computed using the endogenously adjusted poverty line and the new distribution of per capita consumption expenditure) to the baseline equivalents is a measure of the effect of a policy reform on distribution and poverty.[15]

Egypt Social Accounting Matrix

The Egypt SAM for 1997 is the main database for the CGE model. A SAM is a snapshot in time that, most importantly, portrays the flow of incomes from production activities in the form of factor payments to the households and the consequent flow back to product markets through household spending on goods and services. The SAM is a square matrix, whereby row totals must equal column totals. Each cell in the SAM can either represent the payments from a column account to a row account, or, an income received by an activity account from a column account.

The accounts included in the SAM may be divided into production activities, commodities, institutions, and factors of production. Subject to data availability, the SAM accounts in each category may be disaggregated appropriately to address the policy questions explored by the underlying model. In this report, the disaggregation of

[15] For a more detailed description of the approach, see Agénor, Izquierdo, and Fofack (2003). A similar method is followed by Lofgren, Robinson, and El-Said (2003) and Coady and Harris (2004).

production sectors, households, and the government has been informed by our objective of exploring the impact of government spending on poverty.[16]

In addition to the SAM, the model requires information about elasticities (for production, consumption, trade, and the productivity effects of government capital stocks), base-year stocks of factors and debts, as well as data showing anticipated trends for government policies and other exogenous elements that may change over time (international prices, population, and selected factor stocks).

Modeling of Subsidies

The Egypt CGE model has been extended to explicitly account for subsidies as included in the 1997 SAM for Egypt. According to the SAM, subsidies include transfers to households as payments for four commodities: bread, flour, transportation, and electricity. For the model to account for the subsidy data, a number of equations in the model had to be modified to ensure the model's base solution replicates the initial data in the SAM. This entails calibrating the subsidy data into the model. In addition to including existing subsidy data, the model was also extended to include a cash transfer treatment. What follows provides a brief description of these modifications.

Subsidy Rate Treatment

In the model, the household demand is modeled as a Stone–Geary LES functional form. Given the commodity prices and incomes, a typical household would optimize its objective function by choosing an optimal consumption basket. After introducing the subsidy rate, the first order conditions explicitly include an endogenous subsidy rate that can apply to the different commodities in the model. Following the 1997 data in the SAM, these apply to existing subsidized commodities (bread, flour, transportation, and electricity). The subsidy rate can be easily modified (for existing commodities and new ones) as needed for the purpose of implementing a particular policy scenario.

[16] A micro-version of the SAM that is used is available upon request.

Cash Transfer Treatment

The cash transfer is a lump sum that the government decides to spend to target needy household groups. In contrast to the subsidy rate treatment, which operates through prices, the cash transfer treatment amounts to an increase to the recipient's total income. The lump sum transfer comes out of the government budget, while the transfer may be financed by increasing the fiscal deficit, increasing tax revenue, or reducing other expenditures. Alternatively, financing could be associated with foreign grants, which would be reflected as part of the current account.[17] This would have different implications, however, as it depends on the assumptions introduced for the current account equilibrium. Typically this would tend to appreciate the exchange rate and a potential "Dutch disease" story can be analyzed.

Policy Scenarios

Two sets of policy experiments are implemented using the CGE model for Egypt. The first analyzes the restructuring of the subsidy system and uses the resultant savings from targeting, along with a reallocation of public investment toward one specific sector at a time (agriculture, infrastructure, or and human capital [education and health]). The other policy scenario eliminates the price subsidy program completely and, instead, introduces a targeted cash transfer program with a similar use of saved resources and reallocation of public funds toward one of the above-mentioned sectors. The effects on poverty, growth, and efficiency in the economy will be assessed and compared with a baseline growth path. Table 9 provides a brief description of all the simulations under the two sets of policy experiments.

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[17] These are alternatives the model can address through a change in the closure rules related to how the government account maintains a new equilibrium.

Table 9. Assumptions for Nonbase Simulations

Simulation name	Description
Set 1: Targeting the price subsidy program	
SUB1 + QG – AGR + –2	Increasing government spending by amount equivalent to government savings upon restructuring the price subsidy program and shifting government spending from “other” to agriculture
SUB1 + QG – TRN + –2	Increasing government spending by amount equivalent to government savings upon restructuring the price subsidy program and shifting government spending from “other” to infrastructure
SUB1 + QG – HUM + –2	Increasing government spending by amount equivalent to government savings upon restructuring the price subsidy program and shifting government spending from “other” to human capital
Set 2: A cash transfer program	
TRHH + QG – AGR + –2	Increasing government spending by an amount equivalent to net savings from eliminating the price subsidy program and introducing a cash transfers program (which is equal in value to the price subsidy program) and from shifting government spending from “other” to agriculture
TRHH + QG – TRN + –2	Increasing government spending by an amount equivalent to net savings from eliminating the price subsidy program and introducing a cash transfers program (which is equal in value to the price subsidy program) and from shifting government spending from “other” to infrastructure
TRHH + QG – HUM + –2	Increasing government spending by an amount equivalent to net savings from eliminating the price subsidy program and introducing a cash transfers program (which is equal in value to the price subsidy program) and from shifting government spending from “other” to Human Capital

Notes: In all public spending simulations, expansion or reallocation refers to a change in 1998 corresponding to 10 percent of 1997 government demand (or 1.9 percent of GDP). Starting from 1998, all government demand areas grow at a uniform annual real rate of 1.9 percent, unless otherwise noted.

The Distribution of Subsidies

The model solution generates a baseline growth path for the economy with a consistent general equilibrium set of results in each period. The baseline growth path serves as a benchmark for comparing the results from the two sets of policy experiments. Results from the baseline growth path are listed under the second column of Tables 10 and 11.

Table 10. Subsidy Restructuring Scenario and Reallocation of Public Spending, Summary Results

Indicator	1997	BASE	SUB1 + QG – AGR + –2	SUB1 + QG – TRN + –2	SUB1 + QG – HUM + –2
		Annual growth rates, 1998–2015 (percent)			
Absorption	266.32	4.03	3.98	4.41	6.80
Household consumption	195.10	3.90	4.01	4.24	6.60
Government consumption and investment	26.00	4.58	5.06	5.06	4.83
Private investment	45.22	4.27	3.16	4.73	8.85
Exports	59.42	4.17	3.61	4.59	7.89
Imports	66.77	4.32	3.84	4.69	7.66
Real exchange rate	100.00	–0.65	0.43	–0.59	–1.08
Total GDP (at factor cost)	241.09	3.98	3.96	4.38	7.18
TFP index		2.53	2.85	2.84	4.29
Total factor income	241.84	3.58	4.02	3.97	6.48
Private capital	153.82	3.37	4.32	3.80	6.19
Land	19.40	5.89	1.54	5.93	8.76
Agricultural labor	11.23	3.76	–0.46	3.87	6.76
Nonagricultural labor	57.38	3.14	4.48	3.66	6.23
Ratios to GDP		Percentage point deviations from 1997 values			
Investment	22.48	0.38	0.14	0.68	2.14
Government expenditure	22.61	–2.92	–1.22	–2.88	–5.44
Private saving	16.96	–1.02	–1.15	–1.16	–1.41
Government saving	8.59	–1.64	–1.74	–1.19	0.50
Foreign saving	–3.07	3.03	3.03	3.04	3.05
Poverty headcount rate (P0)	16.77	–11.16	–11.72	–12.08	–15.47

Source: Simulation results.

Table 11. Subsidy Restructuring Scenarios for Reallocation of Public Spending: Welfare Indicators

	1997	BASE	SUB1 + QG – AGR + –2	SUB1 + QG – TRN + –2	SUB1 + QG – HUM + –2
		Annual growth rates, 1997–2015 (percent)			
Household consumption per capita					
Rural upper income	8.25	2.70	1.78	2.97	5.65
Rural lower income	0.98	3.53	3.17	3.88	6.79
Urban upper income	18.78	1.04	1.57	1.45	3.84
Urban lower income	1.23	2.83	4.05	3.36	6.18
Average, all households	3.20	2.22	2.36	2.60	5.23
Rural	2.43	2.89	2.22	3.19	5.93
Urban	4.22	1.65	2.46	2.10	4.65
		Percentage point deviations from 1997 values			
Poverty headcount, P0					
Total	16.77	–11.16	–11.72	–12.08	–15.47
Rural	22.03	–14.66	–14.26	–15.59	–20.15
Urban	9.78	–6.52	–8.35	–7.43	–9.25
Elasticity		–1.37	–1.34	–1.23	–0.61
Poverty gap, P1					
Total	5.34	–3.92	–4.07	–4.17	–5.07
Rural	7.28	–5.35	–5.30	–5.66	–6.89
Urban	2.75	–2.01	–2.44	–2.20	–2.65
Elasticity		–1.52	–1.46	–1.33	–0.63
Squared poverty gap, P2					
Total	2.41	–1.87	–1.93	–1.97	–2.32
Rural	3.37	–2.61	–2.60	–2.74	–3.24
Urban	1.14	–0.87	–1.04	–0.95	–1.11
Elasticity		–1.60	–1.53	–1.40	–0.64

Source: Simulation results.
Notes: Household consumption is real per capita consumption. Elasticities for P0, P1, and P2 are the ratios between the percentage change in the poverty indicator and the percentage change in aggregate per capita consumption.

Targeting Through Restructuring the Current Subsidy System

Currently, the subsidy system is untargeted and thus inefficient, thereby exerting an unnecessary strain on government funds. This set of policy scenarios will remove subsidies altogether from society's upper two quintiles in an attempt to remedy the problem of inclusion errors in a subsidy system. At the same time, subsidies for the middle quintile are halved, whereas the lowest two quintiles, considered the most vulnerable, will still receive the full subsidy.

The results are compared with the baseline scenario (Tables 10 and 11). Relative to the baseline scenario, a reallocation of government spending toward a specific sector, combined with additional investment from restructuring the subsidy program entails a positive increase in GDP. Overall, it seems that fiscal prudence pays off only when the government targets infrastructure and human capital development. The results of the macro-indicators are quite disappointing when the government chooses to invest heavily in the agricultural sector. Heavy government investment in the agricultural sector has led to such interesting results in this exercise that it was deemed appropriate to conduct a sensitivity analysis to show the movement of key macro- and household indicators when the agricultural sector is targeted for investment by the government.

Looking at the household and welfare indicators (Table 11), it can be found that, except for the scenario for agricultural sector investment, consumption per capita rises across quintiles and regions. However, under the scenario of agricultural sector investment, it is clear that any increases in per capita consumption are biased in favor of the urban households. Exclusive investment in the agricultural sector does not improve poverty figures (over the baseline results) for the rural sector. This result implies that the negative poverty impacts on the rural poor hampers the government's policy efforts to significantly reduce nationwide poverty.

The consistent results in these three scenarios are that public investment in agriculture shows relatively poorer results relative to public investment in human capital and infrastructure. These results are especially true when evaluating growth.

Targeting Through Cash Transfers

Cash transfers have several advantages over subsidies, such as their allowance for existing price mechanisms and choice in consumption patterns. There are, however, disadvantages to cash transfers, namely the requirement for overly extensive information about the needy than other social protection programs, in addition to the high administrative costs of setting up such programs. This study does not take into account the administrative costs incurred in the initiation and expansion of a cash transfer program in Egypt.

In this scenario, subsidies are completely eliminated and cash transfers—equivalent in amount to the value of the subsidy received before its elimination—are distributed among the lowest two income quintiles, and among the third (middle) income quintile. Cash transfers distributed among the middle-income group, however, are only half the value of the subsidies that particular group received under the eliminated subsidy program. The highest two quintiles receive no cash transfers under this scenario. Again, the savings accruing to the government are in turn invested exclusively, once in agriculture, once in infrastructure, and once in human capital, along with an investment reallocation from the government's "other" investments. Looking at the macro-economy, GDP growth achieves its highest growth with human capital development—a 7.22 percent yearly increase over the period compared with a 3.98 percent increase under the baseline (Table 12). TFP across all scenarios rises; however, the largest increases are under the TRHH + QG – HUM+ –2 scenario followed by TRHH + QG AGR + –2 and TRHH + QG – TRN + –2 scenarios. Total factor income increases by less than 1 percent over the baseline with public spending in infrastructure and agriculture, and by slightly less than 3 percent when the government develops human capital. However, with the deterioration in the agricultural terms of trade, in come from agricultural labor and land rentals falls.

Looking at nationwide and regional per capita consumption and the welfare indicators (Table 13), welfare indicators are favorable for urban lower income groups and unfavorable for the rural lower income groups due to the deterioration in the agricultural terms of trade. Throughout this scenario it may be concluded that despite the unfavorable results of the exclusive public spending in the agricultural sector, overall poverty reduction and growth have been successful, albeit within a narrow margin.

Table 12. **Cash Transfers Scenario for Reallocation of Public Spending: Summary Results**

	1997	BASE	TRHH + QG –AGR + –2	TRHH + QG –TRN + –2	TRHH + QG –HUM + –2
			Annual growth rates, 1998–2015 (percent)		
Absorption	266.32	4.03	4.01	4.43	7.17
Household consumption	195.10	3.90	4.08	4.31	7.01
Government consumption and investment	26.00	4.58	5.06	5.06	4.83
Private investment	45.22	4.27	3.00	4.55	8.72
Exports	59.42	4.17	3.63	4.60	7.93
Imports	66.77	4.32	3.85	4.70	7.70
Real exchange rate	100.00	–0.65	0.40	–0.62	–1.11
Total GDP (at factor cost)	241.09	3.98	3.99	4.40	7.22
TFP index		2.53	2.85	2.84	4.29
Total factor income	241.84	3.58	4.06	4.00	6.52
Private capital	153.82	3.37	4.33	3.80	6.22
Land	19.40	5.89	1.73	6.11	8.94
Agricultural labor	11.23	3.76	–0.29	4.02	6.93
Nonagricultural labor	57.38	3.14	4.50	3.68	6.27
Ratios to GDP			Percentage point deviations from 1997 values		
Investment	22.48	0.38	–0.47	0.05	1.65
Government expenditure	22.61	–2.92	–1.20	–2.86	–5.42
Private saving	16.96	–1.02	–1.00	–1.02	–1.30
Government saving	8.59	–1.64	–2.49	–1.96	–0.09
Foreign saving	–3.07	3.03	3.02	3.02	3.04
Poverty headcount rate (P0)	16.77	–11.16	–11.72	–12.03	–15.47

Source: Simulation results.

Table 13. Cash Transfer Scenarios for Reallocation of Public Spending: Welfare Indicators

	1997	BASE	TRHH + QG – AGR + –2	TRHH + QG – AGR + –2	TRHH + QG – AGR + –2
			Annual growth rates, 1997–2015 (percent)		
Household consumption per capita					
Rural upper income	8.25	2.70	1.80	2.98	5.67
Rural lower income	0.98	3.53	3.35	4.03	6.93
Urban upper income	18.78	1.04	1.54	1.44	3.85
Urban lower income	1.23	2.83	4.28	3.52	6.33
Average, all households	3.20	2.22	2.41	2.63	5.28
Rural	2.43	2.89	2.29	3.24	5.98
Urban	4.22	1.65	2.49	2.13	4.69
			Percentage point deviations from 1997 values		
Poverty headcount, P0					
Total	16.77	–11.16	–11.72	–12.03	–15.47
Rural	22.03	–14.66	–14.26	–15.59	–20.15
Urban	9.78	–6.52	–8.35	–7.30	–9.25
Elasticity		–1.37	–1.33	–1.22	–0.61
Poverty gap, P1					
Total	5.34	–3.92	–4.06	–4.14	–5.06
Rural	7.28	–5.35	–5.28	–5.61	–6.87
Urban	2.75	–2.01	–2.43	–2.18	–2.64
Elasticity		–1.52	–1.45	–1.32	–0.62
Squared poverty gap, P2					
Total	2.41	–1.87	–1.92	–1.96	–2.32
Rural	3.37	–2.61	–2.59	–2.72	–3.23
Urban	1.14	–0.87	–1.04	–0.94	–1.11
Elasticity		–1.60	–1.52	–1.38	–0.63

Source: Simulation results.
Notes: Household consumption is real per capita consumption. Elasticities for P0, P1, and P2 are the ratios between the percent change in the poverty indicator and the percent change in aggregate per capita consumption.

Sensitivity Analysis to Public Investment in the Agricultural Sector

Throughout this study, it was found that increased investment in the agricultural sector does not bring about growth and poverty reduction in that sector. Despite an increase in agricultural factor productivity, results indicated that agricultural labor and land incomes deteriorate, as do certain welfare indicators, such as per capita consumption and rural poverty across the board.

In order to further explore this result, a sensitivity analysis was conducted across the two main safety net programs: subsidy restructuring versus cash transfers. The level of investments in the agricultural sectors varied. For the first set of sub-experiments, all the subsidy savings accruing to the government—either from restructuring the existing subsidy program or replacing it with a cash transfer program—were injected into the sector. The second set of sub-experiments entailed reducing public investment in the sector to three-quarters of the savings accruing to the government from modifying the consumer subsidy program. Finally, to complete the picture, half of the savings were targeted to the agricultural sector. The results indicate falling TFP with lower investments in the agricultural sector (Table 14); however, there is a negative relationship between the level of investments in the agricultural sector and nationwide growth, absorption, and agricultural factor income. At the micro-level, there seems to be a steady improvement in rural per capita consumption and rural poverty incidence when fewer investments are allocated to the agricultural sector.

These results may be explained through the link between productivity increases and the inelastic demand for food in Egypt. Productivity increases raise agricultural production; coupled with low demand elasticities of agricultural products and an almost nonexistent outlet for a higher volume of agricultural exports (agricultural exports were only 0.5 percent of total exports in 1995/96), domestic prices of agricultural goods fall. Agricultural terms of trade deteriorate, and the net buyers of agricultural goods reap the benefits, while the net producers are harmed.

It can, therefore, be argued that a cash transfer scenario may be superior to restructuring the current subsidies. Cash transfers increase real incomes, do not interfere with the consumer's utility maximization, and seem to compensate rural communities for their loss of revenue as a result of the agricultural sector's deteriorating terms of trade.

Table 14. Sensitivity Analysis of Agricultural Spending or Cash Transfer

	Baseline Scenario	Subsidy Restructuring Scenario			Cash Transfer Scenario		
		Allocation of Subsidy Savings to Agricultural Sector					
		Full	Three-quarters	Half	Full	Three-quarters	Half
	Growth, 1998–2015 (percent)						
Per capita consumption							
R1	3.53	3.17	3.27	3.37	3.35	3.27	3.55
R2	3.14	2.93	3.01	3.10	3.07	3.01	3.24
R3	2.98	2.22	2.33	2.45	2.30	2.33	2.53
R4	2.68	2.03	2.13	2.24	2.05	2.13	2.25
R5	2.70	1.78	1.90	2.02	1.80	1.90	2.04
U1	2.83	4.14	4.14	4.13	4.28	4.14	4.28
U2	2.55	3.58	3.60	3.61	3.68	3.60	3.71
U3	2.17	3.15	3.16	3.16	3.19	3.16	3.20
U4	1.49	2.38	2.39	2.39	2.37	2.39	2.38
U5	1.04	1.55	1.58	1.61	1.54	1.58	1.60
Total	2.22	2.36	2.42	2.47	2.41	2.42	2.52
Rural	2.89	2.22	2.33	2.44	2.29	2.33	2.51
Urban	1.65	2.46	2.48	2.49	2.49	2.48	2.52
Poverty incidence							
Total	–11.16	–11.72	–11.93	–12.09	–11.72	–11.93	–12.09
Rural	–14.66	–14.26	–14.64	–14.91	–14.26	–14.64	–14.91
Urban	–6.52	–8.35	–8.35	–8.35	–8.35	–8.35	–8.35
Macro-economy							
GDP at factor cost	3.98	3.96	4.03	4.09	3.99	4.03	4.09
Absorption	4.03	3.98	4.05	4.12	4.01	4.05	4.12
Total factor productivity	2.53	2.85	2.83	2.81	2.85	2.83	2.81
Factor income							
Land	5.89	1.54	1.97	2.43	1.73	1.97	2.43
Agricultural Labor	3.76	–0.46	–0.03	0.42	–0.29	–0.03	0.42
Nonagricultural Labor	3.14	4.48	4.51	4.51	4.50	4.51	4.51

Source: Simulation results.

Policy Recommendations, and Areas for Future Research

Overall, targeted social safety nets reduce the fiscal burden and free funds for use to promote growth and alleviate poverty; they also help to promote the efficient use of resources. Further, targeted social safety nets are more equitable, which is of significant importance in the case of Egypt because such safety nets correct a long overdue bias toward the higher quintiles in the subsidy program.

Our analysis indicates the possible benefits of restructuring the existing price subsidy program in favor of the lowest household quintiles (minimizing the inclusion error), at the same time using the resultant savings to promote and target public spending. In a similar approach, the existing subsidy program was contrasted with an alternative cash transfer program.

Aside from achieving a more equitable distribution of benefits, the results indicate that a targeted cash transfer program promotes higher GDP growth and higher aggregate household consumption than targeted subsidies. Both macro- and micro-indicators are higher under a cash transfer program than under a program targeting subsidies, with the exception of poverty, which maintains similar figures under both scenarios. It was also found that, given the structure of the agricultural sector in Egypt, the rise in productivity is translated into lower domestic prices of agricultural goods and lower agricultural factor incomes, ultimately driving down rural consumption per capita and raising its urban equivalent. By conducting a sensitivity analysis on the level of public investment in the agricultural sector, it was found that the lower the investments in that sector, the higher the macro- and micro-indicators. However, given the inelastic demand for agricultural goods, it was found that cash transfers offer better compensation, compared with consumer subsidies, for its loss of revenue to the rural sector. Another common finding is that, across the board, government spending on human capital development circumvents the deterioration in agricultural terms of trade and thus produces higher growth and more substantial poverty alleviation than investment in infrastructure or agriculture.

It is difficult to argue that the present state of the subsidy program in Egypt is fiscally unsound, and neither can it be said that the program, as it stands, is efficient in providing the truly needy with a social safety net. The merits of undertaking a subsidy reform policy using any of the above scenarios must take into account an administratively feasible program as well as a thouroug understanding of the social and political dimension of reforms.

Even with a means proxy test available for Egypt, a geographical targeting of subsidies may prove to be beneficial, given that the majority of the poor live in rural areas. It can be argued further that geographical targeting of public spending in the social services sector and on infrastructure would more likely reap greater benefits in light of the structure of the Egyptian agricultural sector. This is particularly so given that the highest illiteracy rates and lowest access to health care are concentrated in specific regions in Egypt.[18]

Another area of potential gain from targeting is the provision of support based on gender. Female-headed households constitute 15 percent of all Egyptian households. Illiteracy, social intolerance, poor access to capital, and gender bias in the workplace make female-headed households among the most vulnerable groups in Egyptian society. Gender targeting can therefore help. Supplementing this analysis with data on gender would very likely yield positive results.

[18] Extending the current CGE model to incorporate regional/governorate breakdowns may provide additional analyses and useful results.

VII. SUMMARY AND SYNERGY

This study differs from previous ones in its analysis of the effects of public spending on growth and poverty reduction at different levels of aggregation. The study involves analyses and simulations at the household, sectoral, regional, and macro levels, using different analytical tools as appropriate. This approach has enabled additional knowledge as well as new policy insights to come to light:

1. Our findings conform with results from earlier studies that universal subsidies are inefficient and usually achieve the intended goals at a much higher cost. A targeted approach is preferred since it is more effective in reducing poverty and attaining an equitable distribution of income. Moreover, saved government resources can be reallocated toward more productive investments in human capitals, infrastructure, and agricultural technology that would have long-term effects on growth and poverty reduction. Among all types of targeted programs, direct income transfers, as well as transfers targeted to the aged, women, and children deserve special attention.

2. In order to achieve higher economic growth rates and higher poverty reduction, public investment needs to be prioritized. Investing in human capital and infrastructure, particularly in rural Egypt, offers the highest return in terms of both economic growth and poverty reduction. Regionally, investment in upper Egypt would lead to larger poverty reductions because poor people are increasingly concentrated there.

3. Investing in agriculture is potentially pro-poor and can contribute to long-term national food security. However, current trade policy isolates the domestic market and leads to lower returns to these investments, particularly in terms of rural income and rural poverty reduction. Most of the benefits from agricultural investment, under an autarky economy, are reaped by urban consumers, and the majority of rural population, who are net producers, may suffer.

In summary, investing in agriculture and rural areas is a must to lift the rural poor out of poverty, but securing market access for agricultural exports is a pre-condition for this to happen.

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