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IFPRI Discussion Paper 01210

September 2012

Managing Transition in Yemen

An Assessment of the Costs of Conflict and Development Scenarios for the Future

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PARTNERS AND CONTRIBUTORS

IFPRI gratefully acknowledges the generous unrestricted funding from Australia, Canada, China, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, the Netherlands, Norway, the Philippines, South Africa, Sweden, Switzerland, the United Kingdom, the United States, and the World Bank.

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ABSTRACT

This paper has been produced to support the Government of Yemen and the international community in designing a transition plan for the country. The political crisis and conflict situation in Yemen has led to a sharp decline in economic output beginning in 2011—a decline from which Yemen is estimated to recover only in 2015, if favorable conditions apply. Moreover, the impact of the crisis on the poor is dramatic. Findings from this analysis suggest that

- 54.4 percent of Yemeni people live in poverty (compared with 34.8 percent in 2006 and 42.8 percent in 2009) and
- 61.0 percent of Yemeni children under five are malnourished (compared with 57.9 percent in 2006).

If no decisive action is taken, poverty and food insecurity are likely to further increase. Looking forward, there remain uncertainties and risks about the transition pathway. The space to launch major policy reforms may be limited during the transition period.

But reversing the heavy economic and social costs and leveraging the political transition for rapid socioeconomic development in Yemen will require substantial investments and significant reforms. Model simulations show that

- An additional US$2.4 billion[1] to $4.8 billion of investments are needed over the next four years to accelerate (non-oil) economic growth to 7–8 percent annually and bring poverty and malnutrition down to precrisis levels.
- An additional $3.0 billion to $6.5 billion will be required to sustain and accelerate these growth and poverty reduction gains until 2020.

About 8 percent of the additional investment should be targeted to agriculture; 55 percent to investments in roads, electricity, water, and other infrastructures; and 37 percent to transportation, communication, health, education, and social transfers to make best use of Yemen's growth potential. To ensure that public spending is directed to support growth, reduce poverty, improve inclusion, and address food insecurity, the following are areas of priority:

- Rethink energy subsidies
- Redynamize the business climate
- Reduce qat production and consumption
- Improve food security risk management and make food imports more competitive
- Implement the national water strategy
- Target public investment and improve service provision
- Launch high-level awareness campaigns and leverage the policy dialogue with civil society

Keywords: Yemen, conflict, transition, Arab awakening, poverty, food security, investments

[1] All dollar amounts are in US dollars.

ACKNOWLEDGMENTS

This paper has been produced as part of the Joint Social and Economic Assessment, conducted by the World Bank, the United Nations, and the European Union. We thank the European Union (EU), the International Fund for Agricultural Development (IFAD), and the World Bank for financial support. Specifically we acknowledge the support of Jacques Philippe and Mauro Gioé (European Union), Omer Zafar, Maria Losacco and Leon Williams (International Fund for Agricultural Development) and Bernard Funck (World Bank). We are also grateful for comments and suggestions from Mohamed Al-Hawri (Deputy Minister of Planning, Yemen), Ahmed M. Elsadig, Mohammed Ahmed Zubair, Eri Al Mansoub, (all Islamic Development Bank); Federico Negro, Jean-François Klein, Jaime Arevalo, Lara Uhlenhaut, Manas Bhattacharia (all International Labor Organization); and Xinshen Diao and Margaret McMillan (both IFPRI). We highly appreciate UNICEF Yemen's support in providing the data from their Social Protection Monitoring Surveys and are particularly thankful to Buthaina al-Iryani and Tammy Smith.

1. INTRODUCTION

The Arab Awakening has initiated political and economic transition processes in several countries, including Tunisia, Egypt, Libya, and Yemen. The citizens of these countries have toppled their governments in the quest for more freedom, dignity, and justice (Friedman 2011). Economic factors have also played a role in the uprisings, including growing unemployment, especially among youth; rising inequalities; and high levels of poverty and food insecurity (Abdih 2011; Breisinger, Engelke, and Ecker 2011; Breisinger et al. 2011; Clark 2011; IMF 2011a). While many people took to the streets in the hope of jobs and better lives, the short-term impact of the transition has led to higher unemployment and possibly an increase in poverty (Abdih 2011). This is because some of the countries' long-standing challenges have been exacerbated by the uprisings, slowing economic growth; increasing fiscal deficits, especially in oil-importing countries; and causing decline in foreign exchange earnings from tourism, development aid, and foreign direct investment (Breisinger, Engelke, and Ecker 2011).

Empirical evidence suggests that the economic and social costs of conflict are high. Collier and Hoeffler (2007) calculated that one year of conflict reduces a country's growth rate by 2.2 percent at a global average. For Arab countries the average cost may be even higher. One year of conflict is estimated to cost 3.5 percent of per capita gross domestic product (GDP) and between 5 and 10 years setback in social development, including life expectancy, immunization rate, and human development (ESCWA 2010). Conflict negatively affects food security through a decline in agricultural production, trade, and income (Deininger and Castagnini 2006; FAO 2000), and vulnerable groups in society often bear a disproportionate burden of these developmental costs, especially children, women, and the poor. Armed conflict can increase death rates of children up to 24 times through malnutrition, disease, and displacement, and one additional month of war exposure significantly decreases children's nutritional status compared with that of nonexposed children (ESCWA 2010; Bundervoet, Verwimp, and Akresh 2009).

The short-term socioeconomic impact of transition also poses huge challenges to Yemen. The first major demonstration in Yemen with more than 10,000 people took place in Sana'a on January 27, 2011 (BBC 2012a, 2012b, 2012c). Throughout 2011, conflicts in various parts of the country led to disruptions in the supply of production inputs, and related higher prices have affected all economic sectors. The reduction in availability of fuel, particularly diesel, further aggravated shortages in electricity and water. Power cuts became so frequent that in some areas of Yemen power was available only four hours per day (MoPIC 2012), if at all. The repeated bombing of the pipelines in the Marib and Ras Issa areas and continued road insecurities led to a sharp decrease in crude oil production, by about 25 percent in 2011, and altered transportation costs (MoPIC 2012). These disruptions had far-reaching repercussions throughout the economy. The agricultural, industrial, and service sectors faced significant cost increases for inputs such as irrigation, transportation, and marketing, ultimately reducing production and exports. Production processes were disrupted, leading to businesses' closing and workers' being let go in both the public and the private sectors. Delivery of public goods and services was affected across Yemen, including health, education, and social safety nets.

It is evident that the socioeconomic implications of transition in Yemen have been negative in the short run. Yet transition will also provide new opportunities for development in the coming years. This paper assesses alternative transition pathways to support policymakers, civil society, and international partners in their quest for growth, poverty reduction, and food security in Yemen. More specifically, this analysis first reviews the existing evidence on the economic performance and social impact before and during 2011 (Section 2). It then uses an economywide model with poverty and nutrition microsimulation modules to quantify the short-term poverty and nutrition impacts (Section 3). Section 4 develops four potential futures for Yemen, and Section 5 calculates the costs of achieving the related development outcomes. Section 6 highlights some of the areas where policy reform is needed to support investments, and concludes.

2. YEMEN BEFORE AND DURING 2011: EVIDENCE FROM EXISTING DATA

The Economy Before and During 2011

The fiscal balance in Yemen is heavily reliant on the hydrocarbon sector. By 2011, the fiscal deficit in Yemen had reached 4.4 percent of GDP, despite the increase in the global price of crude oil. Export revenues from oil decreased in 2011 relative to GDP (Table 2.1), and Yemen faced shortages in the production of both crude oil and cooking gas due to security deterioration that led to the disruption of the major pipeline from Marib to Hodeidah, decreasing the production, supply, and revenue-earning potential of the government (IMF 2012). All other fiscal revenue-generating components of the budget suffered as a result of the conflict. Tax evasion exacerbated the shortfall in nonhydrocarbon taxes, and a significant reduction in foreign grants and loans by close to 60 percent and 70 percent, respectively, added to the government's dwindling revenues (MoPIC 2012). On the expenditure side, even though total expenditure and net lending fell in 2011 over 2010, public wages and salaries rose by close to 20 percent in 2011 (MoPIC 2012).[2] Significant reductions in external aid and the need to contain government spending led to a substantial reduction in public investment, helping to control the fiscal deficit, though at the expense of development objectives.

The potential to mobilize resources domestically is limited in the short term. The current account deficit had fallen from 10.2 percent of GDP in 2009 to 3.5 percent in 2011. The decline is mainly attributable to an increase in the export earnings of the hydrocarbon sector and to a decrease in imports, reflecting the depressed demand. Exports of nonhydrocarbon goods fell from 5.7 percent of GDP in 2009 to 1.9 percent in 2011 (Table 2.1), which reflects the impact of the conflict situation on overall economic activity. Nonhydrocarbon exports are expected to marginally increase in 2012 but to remain well beneath their 2010 levels. Whereas exports of hydrocarbons have continued throughout most of 2011, they are expected to decrease in 2012 due to lower production and lower international prices (IMF 2012; EIA 2012), also impacting Yemen's fiscal balance. The current deficit is expected to fall to 1.0 percent of GDP in 2012, based on a macroeconomic framework that does not allow for significant public investments and an ambitious development agenda.

The economic disruptions of 2011, with related price inflation, will also impact outcomes in 2012. The consumer price index rose from 12.5 percent in 2010 to 22.7 percent 2011, indicating a sharp increase in overall price levels. Food prices rose significantly, mainly due to reduced domestic supply and reduced imports, and further exacerbated by transportation and distribution disruptions due to the conflict situation and the deficient physical infrastructure, both factors that adversely affected the overall supply chain. Rising fuel costs led to countless production disruptions as well as steep increases in transportation costs, reaching, at times, 100 percent in urban areas and twice as much in rural areas (MoPIC 2012). Temporarily, domestic gas prices rose to three times their 2010 levels, gasoline prices by 600 percent, and diesel prices by up to 800 percent during 2011 (MoPIC 2012). The current price level is largely determined by the current lack of a normal and efficient distribution network, related to the widespread smuggling of hydrocarbon products, especially diesel.

[2] Only 20 percent of the increase in wages and salaries was the regular annual increase, the rest being increases given public-sector employees for public appeasement at the onset of the conflict, a policy that was implemented throughout the Arab world in 2011 (Breisinger et al. 2011).

Table 2.1—Main macroeconomic indicators, 2009–2012

	2009	2010	2011	2012
	(Annual percentage change)			
Real GDP	3.9	7.7	-10.5	-0.9
Non-oil real GDP	4.1	4.4	-10.0	-1.6
Consumer prices (end of period) 1/	8.8	12.5	22.7	16.1
Consumer prices (period average) 1/	3.7	11.2	17.6	17.1
	(In percent of GDP)			
Investment and savings				
Gross capital formation	13.5	11.6	5.5	11.1
Of which: nongovernment	7.0	7.0	3.5	7
Gross national savings	3.3	7.9	2.0	10.1
Of which: nongovernment	7.0	7.3	4.4	11.0
	(In percent of GDP)			
Public finances				
Total revenue and grants	25.0	26.0	24.6	29.7
Hydrocarbon revenue	14.6	16.4	16.1	16.1
Nonhydrocarbon revenue	8.4	8.4	7.4	9.5
Tax revenues	8.0	6.6	5.2	6.5
Grants	0.4	1.2	1.2	4.0
Total expenditure and net lending	34.6	30.1	29.0	34.7
Subsidies and transfers	10.9	10.8	9.9	12.1
Subsidies	8.2	8.7	7.9	8.5
Petroleum product subsidies	7.7	8.2	7.4	7.9
Transfers	2.6	2.1	2.0	3.6
Fiscal deficit	10.2	4.0	4.4	5.0
(Annual percentage change, unless otherwise indicated)				
Monetary sector				
Credit to private sector	-4.8	8.2	-16.9	7.0
(In percent of GDP, unless otherwise indicated)				
External sector				
Exports of goods	23.3	25.2	26.3	23.1
Hydrocarbon exports	17.6	20.8	24.3	20.6
Nonhydrocarbon exports	5.7	4.4	1.9	2.5
Imports of goods	31.3	28.0	24.7	24.4
Hydrocarbon imports	7.8	7.1	9.0	7.0
Services, net	-3.6	-2.3	-2.2	-2.5
Workers' remittances, net	4.4	4.8	4.0	4.1
Current account balance	10.2	3.7	3.5	1.0
Overall external balance	4.5	3.6	4.1	0.3
Exchange rate (YRL/US$)	202.9	219.6	213.8	…

Source: IMF 2012 and authors' calculations.

Note: YRL = Yemeni rial.

The given GDP structure is a first guide for future growth areas. Before we examine growth patterns in Yemen, Table 2.2 provides an overview of the structure of the economy before the 2011 crisis. Agriculture made up 11 percent of Yemeni GDP, the industrial sector contributed 43 percent, and the oil sector share was 19 percent. The services sector contributed close to 46 percent of GDP, and trade and transportation together made up 20 percent of GDP. The oil sector remains substantial and contributes almost one-fifth of the country's GDP. Both the agricultural and industrial sectors are import reliant, with import intensities of 45 and 39 percent, respectively. Industry makes up close to 72 percent of the import bill, with food processing alone using up 28.5 percent of Yemen's import value.

Table 2.2—Structure of the Yemeni economy by sector

	GDP share	Private consumption share	Export share	Export intensity	Import share	Import intensity
Agriculture:	11.1	22.8	5.4	10.1	28.5	44.9
Cereals	0.8	10.1	0.1	1.6	19.5	88.3
Cash crops	3.6	7.6	1.1	7.6	6.4	36.4
Qat	3.5	5.1				
Livestock	2.2		0.4	3.4	2.6	22.6
Fishery	1.0		3.8	59.3	0.1	2.8
Industry:	43.2	45.4	94.4	36.6	71.6	38.9
Oil and gas	19.4	1.0	79.1	92.3		
Food processing	3.5	27.3	2.0	5.0	28.5	52.5
Other industry	12.7	15.6	13.3	15.7	43.1	46.7
Electricity and water	1.2	1.5				
Construction	6.4					
Services:	45.8	31.7				
Trade and transportation	20.0	12.5				
Other private services	11.3	13.3				
Education and health	5.8	5.9				
Other public services	8.7					
Total:	100.0	100.0	100.0	17.2	100.0	23.1

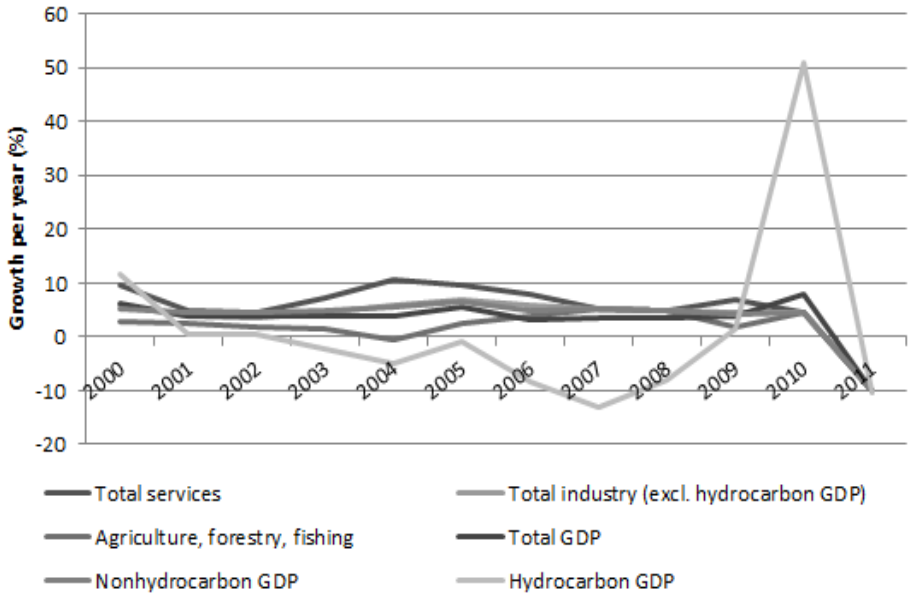
Source: Yemen dynamic computable general equilibrium model.

Notes: GDP shares are for 2009. Import intensities are calculated as shares of total domestic consumption (final and intermediate). Export intensities are the ratios of exports to domestic production.

Aggregate consumption is heavily reliant on food and agricultural products while hydrocarbon exports are the prime source for foreign exchange. Yemen is heavily dependent on food imports; 57 percent of Yemen's imports are imports of food and agricultural products. Close to a fifth of its total imports are imports of cereals, thus making Yemen very susceptible to global food price volatilities, especially with a diminishing oil supply and overall diminished foreign exchange earning potential. The oil and gas sector provided the bulk (about 70 to 80 percent) of foreign exchange earnings for Yemen over the last decade, followed closely by agriculture's share of exports of just under 6 percent. About 50 percent of Yemen's total private consumption is of food (including agriculture and food processing). Losing the foreign exchange revenue potential of the oil sector would put into question the ability to import the required quantities of food products.

Providing services is the main economic activity besides the oil sector. Before the political crisis in 2011, Yemen maintained a stable, albeit modest, growth pattern throughout the first decade of this century (Figure 2.1). Overlooking the growth spikes in the hydrocarbon sector mainly triggered by the international price of oil and the beginning of new gas production in 2010, Figure 2.1 shows that growth in the agricultural sector has been declining and growth in the industrial sectors (excluding oil) and the nonhydrocarbon sectors as a whole has been almost nonchanging. The only sector that appears to be growing relatively more than the other non-oil sectors is the services sector.

Figure 2.1—Growth trends, 2000–2011



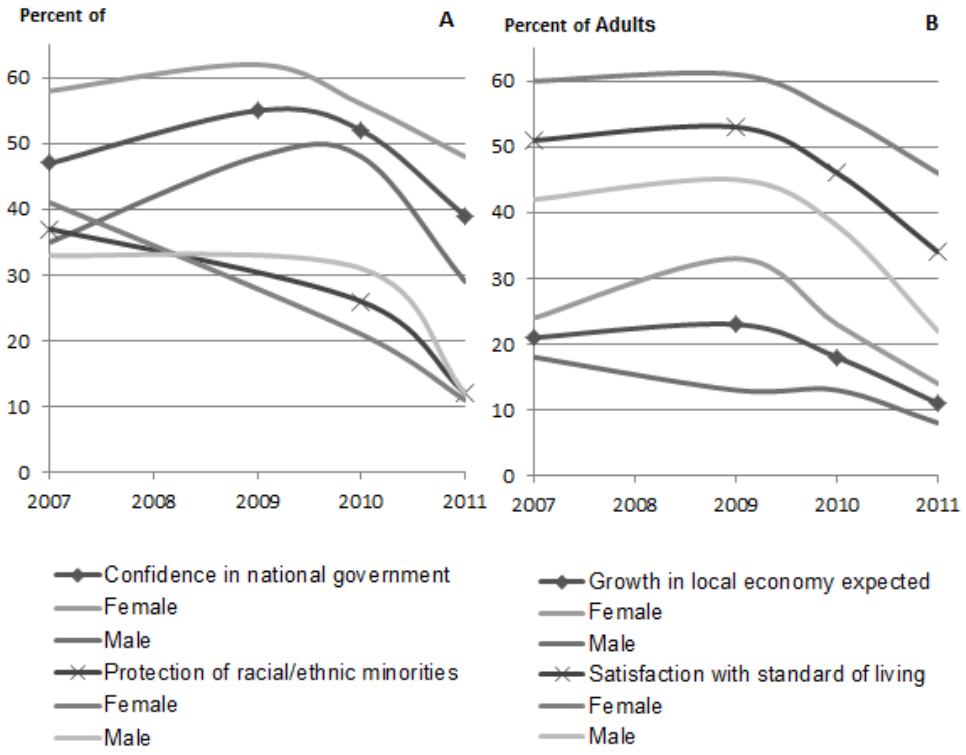
Source: IMF 2012 estimates and author's calculations.

The political crisis in 2011 led to a sharp drop in economic growth in 2011, which likely further increased poverty and food insecurity. Even before 2011, poverty and food insecurity levels in Yemen were the highest in the Arab world (Breisinger et al. 2010), with 32.1 percent of the population food insecure (GoY and IFPRI 2010). In 2009, 59.4 percent of all children were stunted (or too short for their age), mainly due to poor nutrition and health. Child malnutrition (stunting) is also much more pronounced in rural areas than in urban areas: While 47.7 percent of urban children are considered malnourished, 63.5 percent of their rural fellows suffer from malnutrition (MOPIC and IFPRI 2010). Preliminary findings of the WFP Comprehensive Food Security Survey (CFSS) suggest that in late 2011, 44.5 percent of the Yemeni population—over 10 million people—suffered from food insecurity (WFP 2012), up from 32.1 percent in 2009. To quantify the impact of the political crisis on the Yemeni people, the next sections use perception-based surveys followed by economywide modeling with microsimulations.

Perceptions of Yemenis: Evidence from the Gallup World Poll

The Gallup World Poll provides rich information on perceptions held by Yemenis about the political and economic situation between 2007 and 2011 (see Figure 2.2). It does not measure government performance, economic conditions, household welfare, and the like directly but rather questions people about their perceptions regarding these factors. Hence, it also adds an important dimension to the analysis by capturing people's sentiments that appear to be particularly relevant in the context of analyzing conflict impacts.

Figure 2.2—Trends in perceptions on political and economic conditions in Yemen



Source: Gallup 2012.

Notes: The presented indicators are based on the following questions and answers:
Confidence in national government: "In this country, do you have confidence in each of the following, or not? How about national government?"—"Yes."
Protection of racial/ethnic minorities: "Is the city or area where you live a good place or not a good place to live for racial and ethnic minorities?"—"Good place."
Growth in local economy expected: "Right now, do you think that economic conditions in the city or area where you live, as a whole, are getting better or getting worse?"—"Getting better."
Satisfaction with standard of living: "Are you satisfied or dissatisfied with your standard of living, all the things you can buy and do?"—"Satisfied."
The surveys were conducted in face-to-face interviews with men and women aged 15 years or older. The data are representative at the national level and for both genders. See Gallup (2011) for more information.

The data show that Yemen's political and economic conditions have been deteriorating since the second half of 2009. While confidence in the national government grew slightly during and after the global food and fuel crisis, it plummeted in the course of the recent uprisings (Figure 2.2, panel A).[3,4] In 2011, less than 40 percent of the adult population had confidence in the national government. Another indication for increasing government failure in providing security, fostering inclusiveness, and facilitating social equity is the degree of protection of minorities. Only 12 percent of the Yemeni adult population considered their city or area a good place to live for racial and ethnic minorities in 2011. This share has dropped by two-thirds since 2007 (Figure 2.2, panel A). Since the first Gallup survey in 2007, confidence in most state and state-controlled institutions is at a record low in 2011, while it was already at very low levels even before the recent political crisis. In 2011, less than or around 40 percent of the adult population had confidence in the local police, financial institutions, and the media, and even less than 30

[3] See Breisinger and others (2010) for more information on the growth and poverty effects of the 2007/08 global crisis.

[4] The 2011 observations in Figure 2.2 are averaged from two survey administrations in February/March and June/July (that is, after the outbreak of the recent uprisings). The data therefore capture parts of the impact of the revolution.

percent in the judicial system, the healthcare system, and the honesty of elections (Table 2.3). The vast majority of people seem to trust only religious institutions and—at least until mid-2011 and to a much lesser extent—the military. Compared with 2009, confidence in all state and state-controlled institutions has declined significantly, with the exceptions of the media and, perhaps surprisingly, the judicial system. Strikingly, people lost the most confidence in the national government directly and its ability to conduct fair elections, whereas religious institutions gained people's confidence. Overall, the Gallup survey data consistently suggest a strong trend of governance erosion.

Table 2.3—Confidence in state, state-controlled, and religious institutions (percent of adults)

	2011	Change from 2009
National government	39	-16
Honesty of elections	29	-14
Judicial system	29	6
Financial institutions	38	-4
Healthcare	29	
Local police	39	-8
Military	65	-3
Religious organizations	88	5
Media	41 *	8

Source: Based on Gallup 2012.

Notes: *2010 estimate.

The presented estimates are based on the following question and answer:

"In this country, do you have confidence in each of the following, or not? How about …?"—"Yes."

The Gallup World Poll further suggests that governance and perceived economic conditions are closely correlated in Yemen. A vast and, since 2009, rapidly growing majority of adults expect worsening of the national and local economy. Down from 23 percent in 2009, only 11 percent of the adult population in 2011 foresaw improving economic conditions in the city or area where they live (Figure 2.2, Panel B). When interviewed about the conditions of the national economy, people's responses yielded absolutely identical levels in 2009 and 2011, while the rise of the recession in the national economy had mainly already been perceived from 2009 to 2010. Accordingly, people's satisfaction with their standard of living had been shrinking drastically. While more than half of the adult population (53 percent) was satisfied with its standard of living in 2009, only one-third (34 percent) was satisfied in 2011.

Pessimism about economic conditions and, even more so, one's own standard of living has not only been widespread and rapidly increasing in recent years but has also proven to be justified over time. People's satisfaction with their living standards fell continuously after 2009, while it appears that the sharp fall in 2010 and thereafter was anticipated. When asked about their expected standard of living in the future, most people said they expected worsening of their situation compared with their present status. This trend is consistent over the period 2007–2011, and the largest drop appeared in 2009 in view of the rising recession. In general, women have been continuously more optimistic than men with respect to most of the analyzed factors. However, it is not evident from the Gallup data that younger Yemenis have been consistently less confident in state institutions, less satisfied about their standard of living, and therefore less optimistic about the future than their elders.

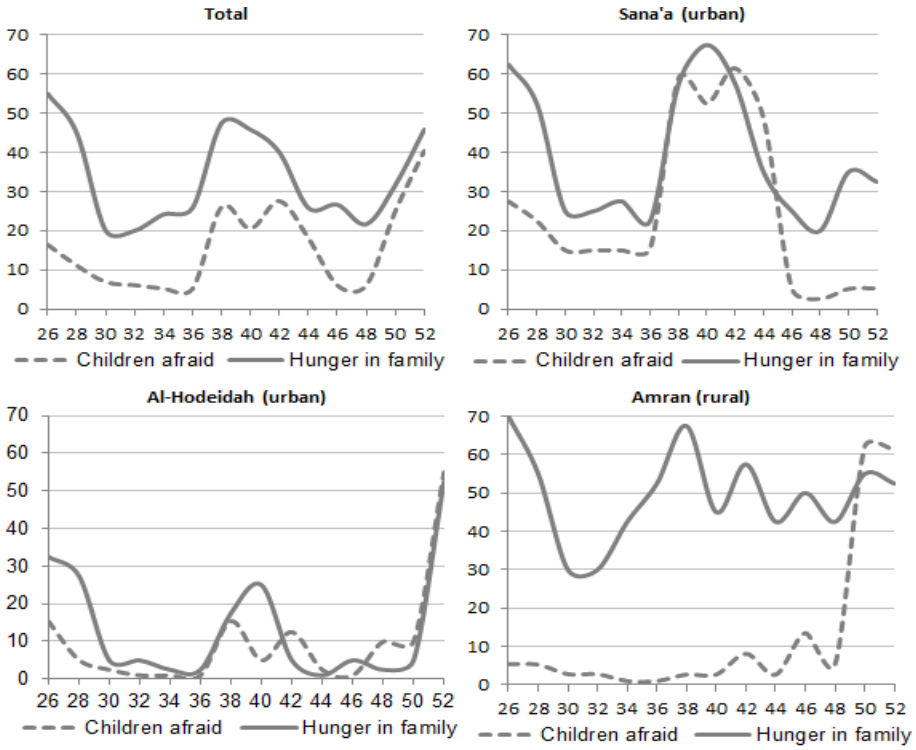
Evidence from UNICEF's Social Protection Monitoring Survey

To investigate the relationship between conflicts and food security at the local level and on a short-term basis, this section consults data from a very recent, small-scale social protection monitoring (SPM) survey carried out by UNICEF (2012). UNICEF's SPM survey is particularly valuable because it is a biweekly panel survey, which allows for very frequent monitoring of the well-being of a particular household over

time and thus for analyzing household responses to shocks in a timely manner.[5] The following analysis makes use of 14 rounds of the SPM survey that were conducted between July 1, 2011, and January 1, 2012 (calendar weeks 26–52), and hence cover the second half of 2011, when conflicts intensified and spread over the country.[6] Survey sites included urban areas in Sana'a Governorate, urban areas in Al-Hodeidah Governorate, and rural areas in Amran Governorate.

As expected, conflict and food security are correlated for the total sample as well as for each governorate subsample.[7] The correlation is highest in the sample from urban Al-Hodeidah and lowest in the one from rural Amran. Graphical presentations of the trends suggest a close co-movement of the prevalence of food-insecure households and the prevalence of households affected by conflict, particularly in urban areas (Figure 2.3). Furthermore, when the total sample is divided into households affected by conflict and those not affected, and the trends in food insecurity of the two household groups are graphed separately, the graph reveals that the food situation among affected households is much more volatile.

Figure 2.3—Conflict and food insecurity in selected areas during the second half of 2011 (percent of sampled households)



Source: Based on UNICEF 2012.

Notes: The calendar week is assigned along the x-axis.
The percentages of households with children afraid of playing outside and with a hungry family member are based on the following questions (addressed to the children's caregiver):
"During the past two weeks have you or any family member experienced going to bed hungry due to lack of food?"—"Yes." "During the past two weeks has any child become afraid of playing outside?"—"Yes."

[5] The answer to the question of whether children in the household are afraid of playing outside serves as proxy variable for direct exposure to conflict, and the answer to the question of whether anybody in the household experienced hunger serves as variable to assess household food insecurity. Both questions were addressed to the person in charge of childcare and meal preparation, who was female in all cases.

[6] In each round, 120 households were interviewed, 40 households from each survey site. The total sample (including all 14 rounds) contains 1,680 observations for the food insecurity variable and 1,621 observations for the conflict variable. At the time of the surveys, no children were present in 59 of the households.

[7] See Table A.1 in Appendix A.

The food security situation also appears to have drastically increased in areas that do not directly experience violent clashes, due to the influx of internally displaced people, price surges, and severe fuel shortages (OCHA and ACAPS 2012). To detect causality in the data, we apply a simple fixed-effects logit model.[8] We model food insecurity as a function of conflict, controlling for fixed effects (between locations and over time) and a uniform trend in the data. We test several specifications considering time lags in household food security response to conflict and spillover effects of conflict appearing in the neighborhood. Taken together, estimation results suggest that expanding conflict increases food insecurity, while the general risk of conflict in the neighborhood seems to matter more than the direct exposure to conflict for individual household food security (Table A.2). In addition, household food security seems to respond instantaneously for the most part, as insignificant or relatively weak coefficients of the lagged variables imply.

[8] See Table A.2 in Appendix A.

3. SHORT- AND MEDIUM-TERM IMPACT OF TRANSITION UNDER ALTERNATIVE SCENARIOS (2011–2020)

To assess the short and medium-term impact of transition, we build a dynamic computable general equilibrium (DCGE) model for Yemen. The model links the macroeconomic parameters, economic sectors, and households via factor and commodity markets and runs from 2009 to 2020. The DCGE model also links to microsimulation models to assess impacts on poverty and nutrition. It is thus a powerful tool for evaluating alternative future scenarios that essentially try to capture the central conditions for economic growth, poverty reduction, and reduction in child malnutrition. The model is described in detail in Appendix B, while the following section describes the scenarios.

Description of Scenarios

Baseline Scenario – The Comparator Scenario

The baseline mirrors a calculated trend, along which Yemen may have developed as if there was no 2011 crisis moment and therefore no transition period but *normal* average development as prior to 2011. This baseline (business-as-usual) serves to calibrate the basic parameters in the model and follows Yemen average annual growth rate of 4 percent over the last decade (Figure 3.1). It is assumed that this growth is driven by gains in total factor productivity (TFP) in the non-agricultural sectors by 2 percent annually. Population and the labor force are assumed to grow at 3 percent, annually. Government consumption spending, transfers to households and remittances are all presumed to grow at the economy-wide growth level of 4 percent per annum. The assumptions for all scenarios are summarized in Appendix Table C.3.

Slow Transition Scenario

For the slow transition scenario it is assumed that no additional external assistance is provided – additional to the annual level observed over the last decade. Furthermore, it is assumed that the government's capacity to reform remains limited and therefore TFP growth remains slow. Both factors limit the growth prospects.

The Stagnation Scenario

The stagnation scenario may be interpreted as the worst case scenario. It reflects the case in which the Yemeni economy stagnates after experiencing the impact of the 2011 crisis. In other words, the scenario simulates zero change in TFP. Population and the labor force are assumed to grow at 3 percent, annually. Government consumption spending, transfers to households and remittances are all presumed to grow at 0 percent per annum.

Accelerated Transition Scenarios

All transition scenarios are the same until end 2012 (see Section 2). From 2013 onward, four different transition scenarios are developed to assess the impact of possible transition paths:

For the agriculture-led transition scenario we assume an increase in TFP growth across all agricultural activities by 1 percent annually between 2013-20 to reflect early gains from recovery and additional investments in the sector. Agricultural TFP growth thus remains slower than in other sectors, given the limits of agricultural potential in Yemen. The underlying rationale of this scenario is that there is still unexploited agricultural potential and that this potential can be realized by additional investments and factor combination, especially by increasing water productivity and structural policy changes within the sector.

Industry-led growth scenarios project TFP growth in electricity, water, construction, mining (excluding oil and gas), food processing, and other manufacturing sectors of 4 percent annually between

2013-2020 (in addition to the 2 percent in the baseline). The underlying assumption is that public spending on electricity, water, roads and other infrastructure accelerates growth in construction and other industrial sectors directly and indirectly.[9]

The service-led growth scenario also assumes 4 percent annual TFP growth rates from 2013-2020 (in addition to the 2 percent in the baseline) in trade, transportation, other private services and social services. This reflects the large potential for improving trade (for example, upcoming WTO membership) and transport systems and related gains from promising sectors such as tourism. In addition, given the low levels of major health and educational outcomes for Yemen, there is huge scope for expanding the related public services for improving social outcomes.

The "accelerated transition scenario" combines the assumptions of all three sector-led scenarios to assess their joint impact. It thus reflects an optimistic scenario, in which Yemen reaches a growth level of 8-9 percent annually between 2014 and 2020 (high growth scenario).

Costing of Growth Acceleration

Accelerating growth comes at a cost and is likely to require significant amounts of additional investment. To assess the size of additional spending required, an elasticity-based three-step approach is applied.[10] In the first step, public spending patterns in Yemen are calculated by sector from 2008 to 2010 using data from the Ministry of Planning and International Cooperation (MoPIC 2010) as a base (Table 3.1). Shares per sector are then derived to calculate total spending by sector and to match the IMF's estimates on average total spending between 2008 and 2010. In the absence of Yemen-specific data that would allow for the calculation of elasticities of overall growth-to-sector investment growth, the additional spending required is estimated using the data produced by Fan et al. (2012) and Breisinger et al. (2012) that may best reflect Yemen's specific conditions (Table 3.1). As suggested by Breisinger et al. (2011), there seems to be no positive relationship between investments in agriculture and growth in the Arab world. Taking a more positive perspective, it is assumed that a more positive relationship exists for Yemen; to remain conservative it is then assumed that the elasticity for investments in agriculture and growth is as low as the lowest found elsewhere, which is the regional estimate for Latin America (Fan et al. 2008), amounting to 0.006, compared with 0.082 globally. For the industrial sector, the global investment-to-growth relationship is used and adjusted for the size of the industrial sector in Yemen (Table 3.1). For the service sector, the elasticity for the whole of the Arab world is used, as estimated by Breisinger and others (2012). This approach yields a spending-to-growth elasticity for industry-led growth of 0.207 and for service-led growth of 0.309. For all three cases it is assumed that the calculated averages reflect an optimistic scenario or a high efficiency of public spending (high spending efficiency). To consider a more pessimistic scenario, the assumption is that the above-mentioned elasticities are only half, which, by definition, would then translate any additional public spending into only half of the growth—or the other way around, one needs to spend double the amount of money to achieve the same level of growth as under the high efficiency of public spending hypothesis.

[9] Infrastructure spending obviously also benefits agriculture and service sectors and these linkage effects are captured in the DCGE model.

[10] It is important to note that the approach taken makes several assumptions. First, it assumes that investment sectors can be matched to economic sectors. However, in reality that is more difficult: For example, investments in hospitals and schools would fall under the health and education budget, but the construction activity would contribute to growth in construction (or industry). Second, it assumes that most growth in one investment sector benefits the respective economic sector, while especially in the longer run, investments in one sector (for example in services) also benefit other sectors, an effect that is only partially captured by the DCGE model.

Table 3.1—Public spending and elasticities

	Public investment				
	2009	2010	Total spending (in million US$)*	Elasticity of overall growth-to-sector investment growth	
Sector	(in % of total public investment)			Optimistic	Pessimistic
Agriculture and fisheries	3.5	1.8	584	0.006	0.003
Agriculture	3.2	1.5			
Fisheries	0.3	0.3			
Industry	54.4	68.8	5,394	0.207	0.103
Electricity and water	18.5	46.4			
Public works, roads, and housing	23.8	16.1			
Other	12.1	6.3			
Services	42.1	29.5	3,706	0.309	0.154
Transportation and communication	4.2	4.3			
Education and health	10.4	7.5			
Social safety net	9.9	3.7			
Other	17.7	13.9			
Total	100.0	100.0	9,683		

Source: Authors' calculations based on MoPIC 2010.

Note: *Total spending by sector is estimated based on the average public investment shares by sector from MoPIC between 2008 and 2010 and the IMF's total public spending number average for the same years.

To relate the changes in overall growth projected by the DCGE model to the additional public spending required to achieve this growth, we divide the additional non-oil growth under the respective transition scenario (agriculture-led, industry-led, service-led and accelerated transition) by the growth rate of the slow transition scenario and then by the elasticity of non-oil growth to sector investment growth as follows:

$$\left(\left\{ \left[\frac{(1+\text{growth of non-oil GDP}_{Transition\ Scenario,t}/100)}{(1+\text{growth of non-oil GDP}_{\text{slow transition},t}/100)} \right] \right\} \Big/ elasticity\ of\ non-oil\ growth\ to\ sector\ investment\ growth \right) * 100. \quad (1)$$

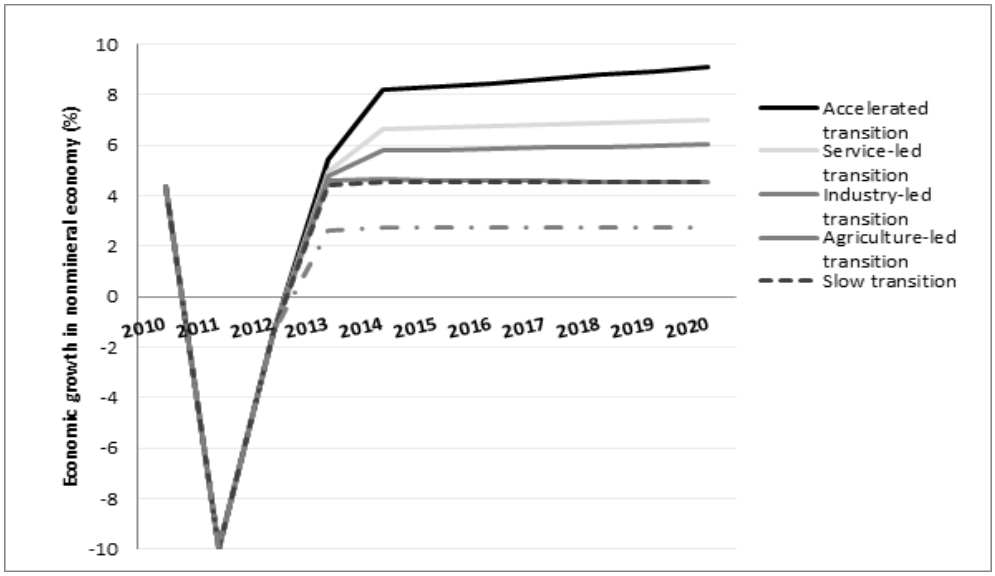
Results show that public spending on agriculture will need to increase at 7.4–14.9 percent annually; public spending on roads, electricity, water, and other infrastructures by 5.7–11.4 percent annually; and public spending on transportation, communication, health, education, and social transfers by 6.3–12.5 percent annually, on average. To calculate the absolute amount of additional spending required per year, we multiply these growth rates in spending i each year by the baseline dollar amount of spending by sector in the respective year. As discussed above, the assumption for the baseline scenario is that public spending grows consistently with the average annual GDP growth rate of 4 percent per year. Results are reported in Table 3.6.

Impact of the 2011 Growth Contraction on Poverty and Malnutrition

The sharp slowdown in growth in 2011 has affected all sectors of the economy (Figure 3.1). Model results suggest that services are hardest hit, shrinking by 13.3 percent in 2011. This result is driven by the sharp decline in public spending, which pulls down public services further, a reduction of 14.7 percent, compared with other services such as trade, transportation, and other private-sector services, which

decline by 12.6 percent. The agricultural sector also suffers by a reduction in output of 10.3 percent, driven by sharp reductions in returns on land, reflecting a situation in which the lack of inputs such as water substantially influences production. According to the simulation, industry is the least-hit sector, shrinking by 3.5 percent in 2011. This result is driven by the fact that construction as part of the industry sector is the largest recipient of domestic investments, which continue to flow in 2011. This implies that investing in houses or (re)constructing buildings and infrastructure continues despite the crisis situation. Although this is subject to confirmation when more accurate numbers become available, it is important to keep in mind that the main purpose of this paper is to estimate the impact of the contraction on poverty and malnutrition. For that purpose, the overall decline in growth is more important than the specific sector experience (sector-level details).

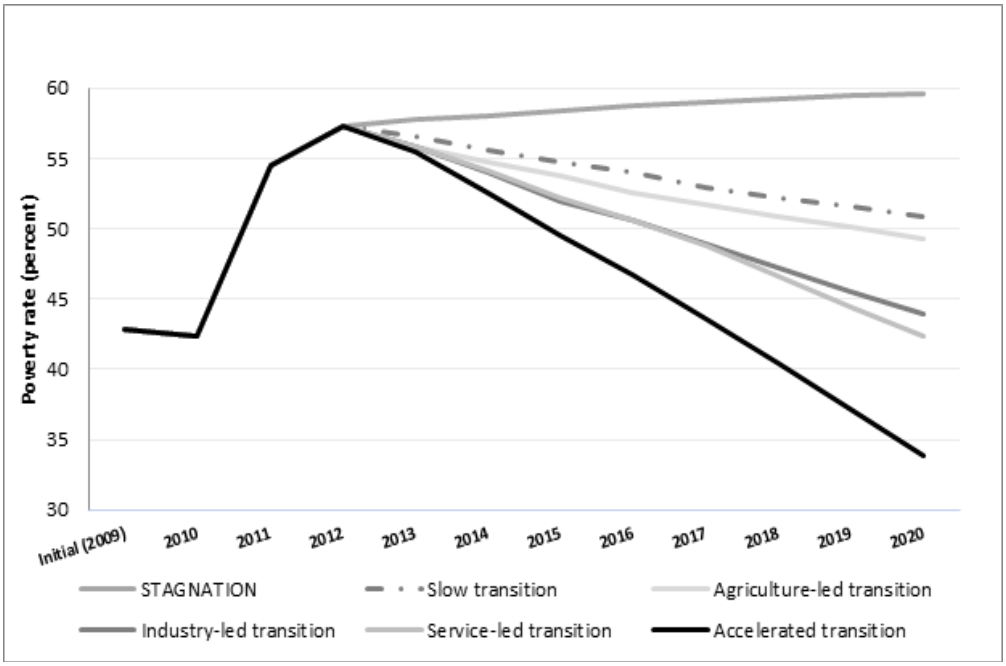
Figure 3.1—Economic growth under stagnation, slow transition, and rapid transition



Source: Yemen dynamic computable general equilibrium model.

The 2011 economic contraction has led to an estimated increase in poverty to 54.4 percent (Figure 3.2), with a stronger effect on urban households. The conflict has sharply driven down household income through higher unemployment and falling wages for public- and private-sector work at all skill levels. In addition, prices for major goods and services, such as food and fuel, have risen as a consequence of lower supply, thus reducing households' real incomes. Thus, household expenditures, the basis for calculating poverty, also sharply decline. Overall household expenditures decline by 16.8 percent in 2011, with urban households suffering higher losses (18.7 percent) than rural households (13.8 percent). In terms of poverty impact, urban households are also relatively and absolutely more affected than rural households. Urban poverty rises sharply, by 13.3 percentage points, from 29.9 percent in 2009 to 42.4 in 2011, which may reflect the fact that many of the uprisings took place in urban areas while many rural areas may have been affected only indirectly. Rural poverty rises from its very high precrisis level of 47.6 percent further to 59.0 percent in 2011.

Figure 3.2—Poverty changes under stagnation, slow transition, and rapid transition



Source: Yemen dynamic computable general equilibrium model.

Child malnutrition has increased, too, although it is less responsive to economic shocks than is poverty. According to our predictions (Table 3.2), the prevalence of child stunting would increase by more than 2 percentage points between 2009 and 2013 (or around 0.7 percentage points per year) from an already very high level of 59.4 percent in 2009 (MoPIC and IFPRI 2010). In general, the child stunting rate is much less sensitive to economic shocks than the poverty rate is, mainly because of the relevance of nonincome factors for nutrition outcomes and the long-run nature of the nutrition indicator used.

Table 3.2—Prevalence of child stunting and annual changes under different growth scenarios, 2009–2020

	Stunting rate (percent of children under 5)				Annual change (percentage points)	
	2009	*2011*	*2013*	*2020*	*2009–2011*	*2013–2020*
Baseline	59.4	59.2	58.9	58.0	-0.13	-0.13
Stagnation	59.4	61.0	61.7	61.8	0.82	0.02
Slow transition	59.4	61.0	61.5	60.4	0.82	-0.16
Agriculture-led transition	59.4	61.0	61.4	60.4	0.82	-0.14
Industry-led transition	59.4	61.0	61.4	59.4	0.82	-0.30
Service-led transition	59.4	61.0	61.4	58.4	0.82	-0.43
Accelerated transition	59.4	61.0	61.3	57.0	0.82	-0.63

Source: Yemen dynamic computable general equilibrium model and microsimulation models.

Alternative Scenarios from 2012 to 2020

In this section we develop four scenarios to project potential future outcomes for Yemen in terms of economic growth paths, poverty, and malnutrition.

The recession in 2011 heavily affects medium- and long-term growth in Yemen under all scenarios (Table 3.3). Except for the accelerated transition scenario, average growth in private

consumption, exports, and imports between 2012 and 2020 is lower than it would have been without the downturn in 2011. Average annual growth over the whole period is between 0.3 and 1.6 percentage points lower. Only under the accelerated scenario is average annual growth higher than in the baseline scenario, implying that only if the conditions for the accelerated transition scenario are assembled can Yemen catch up and rise above levels that may have been achieved in the absence of the sharp conflict-related recession in 2011.

Table 3.3—Changes in macroaggregates over the medium to long term

	Average annual change 2010–2020 (in percentage points)							
	Initial	Base	Stagnation	Slow transition	Agri-led transition	Industry-led transition	Service-led transition	Accelerated transition
GDP (C + I + G + E - M)	100.0	3.9	1.4	2.3	2.3	2.9	3.6	4.5
Private consumption (C)	84.3	3.9	1.0	2.2	2.4	3.0	3.3	4.3
Investment (I)	13.7	1.8	4.3	3.1	1.6	2.3	5.5	5.6
Government consumption (G)	14.9	4.0	-0.9	2.0	2.1	2.1	2.1	2.1
Exports (E)	28.6	3.0	2.3	2.0	2.0	2.2	2.8	3.2
Imports (M)	41.5	2.7	1.7	1.9	1.9	2.0	2.5	2.8

Source: Yemen dynamic computable general equilibrium model.

If no action is taken and political turmoil continues, Yemen is likely to suffer for years to come from low growth. If stagnation continues, then the economywide growth rate is projected to drop to 1.4 percent annually, well below the population growth rate of 3 percent. All sectors would perform below their baseline levels, where agriculture is the most resilient sector with projected growth of 0.1–0.3 percentage points below the slow transition scenario, compared with 1.3–1.6 percentage points and 2.3–2.5 percentage points for the industry and service sectors, respectively.

Even if the economy bounces back to precrisis-level growth rates from 2013 on, it will take until 2015 for Yemen to reach its precrisis GDP. Thus, the crisis in 2011/12 throws Yemen back five years in terms of economic development; that is, Yemen will achieve only in 2015 of the economic output the country produced in 2010. If no additional action is taken and a business-as-usual approach is applied comparable to the one prevailing before the crisis, then Yemen will not catch up within five years. Thus, to make up for the lost half decade, growth acceleration is urgently needed, yet it is not clear which growth path the country will take from 2013 onward. Figure 3.1 shows how the nonhydrocarbon growth rate is expected to perform under alternative possible futures, outcomes of which are described in the following.[11]

Agriculture-led growth accelerates economywide growth throughout the whole transition, albeit at modest levels. Model results suggest that the agricultural sector will grow between 2.3 and 2.6 percentage points above the growth of the slow-transition scenario, in which no additional investment in the sector is undertaken. However, agriculture-led growth is less effective in accelerating economywide growth than are industry- and service-led growth (Table 3.4). The main reason is that the relatively low share in GDP (around 11 percent) of the agricultural sector limits its overall growth impact. Also, given the severe water constraints in the country, initial gains in agricultural growth can most likely not be sustained over time and will therefore recede from 2015 onward, nevertheless staying above the slow transition–scenario level.

[11] We focus the description on the non-oil growth rate since estimates about the future of oil growth are highly uncertain. Most analysts agree that oil resources are being depleted, yet some argue that there are substantial gas reserves that may be able to at least partly offset the losses from oil.

Growth led by industry is driven by the mining (excluding oil and gas), food processing, other manufacturing, electricity, water, and construction sectors, which accelerate over time and substantially push the non-oil growth rate to 6 percent in 2020, 1.4 percentage points higher than under the slow transition scenario (Table 3.4). The industrial sector itself accelerates its growth from 3.1 percentage points above the slow transition level between 2013 and 2016 to 4.4 percentage points above the slow transition level between 2017 and 2020. Industry-led growth also has positive spillover effects to other sectors, especially the service sector. The service sector also strongly benefits from industry-led growth and expands by about 1 percentage point faster annually than under the slow transition scenario, particularly trade and transportation sectors.

Under the service-led scenario, non-oil growth by 2020 is even higher, reaching 3.6 to 4.2 percentage points above growth under the slow transition levels (Table 3.4). This is because the service sector is the largest sector in the economy, with a share of GDP reaching 46 percent and with strong backward and forward linkages to other sectors. Higher productivity in trade, transportation, communication, and social services lowers costs and accelerates growth in agriculture by 1.1 percentage points and in industry by 3.1 percentage points between 2013 and 2016. Combining the growth acceleration in the agriculture, industry, and service sectors would bring Yemen quickly back to precrisis levels and put it on an accelerated growth path. Under this scenario, non-oil annual growth rates reach 7.6 percent on average in the first phase (2013–2016) and then 8.9 percent in the second phase of the recovery (Table 3.4). The industrial-sector growth is the fastest, between 3 and 3.6 percent annually, followed by service-sector growth, projected to be within a range of 2.5 to 3 percent annually. Agriculture grows at 1.3 percent annually in the first phase, but then its growth slows down in the second phase. This is because productivity in other sectors is growing faster than in agriculture and absorbing capital and labor in a way that raises wages and capital costs economywide.

Table 3.4—Projected growth rates by sector

		Initial	2010	2011	2012	2013–2016	2017–2020
Stagnation	Growth	100.0	3.9	-10.0	-1.3	2.8	2.9
	Agriculture	11.0	2.8	-10.3	-1.3	2.5	2.6
	Industry	43.3	5.0	-3.5	-0.5	3.8	3.6
	Services	45.7	4.5	-13.3	-2.0	2.1	2.2
	Oil	19.4	2.1	-10.4	-0.9	3.0	3.4
	Non-oil	80.6	4.4	-10.0	-1.4	2.7	2.7
Slow transition	Growth	100.0	3.9	-10.0	-1.3	4.2	4.2
	Agriculture	11.0	2.8	-10.3	-1.3	2.8	2.7
	Industry	43.3	5.0	-3.5	-0.5	5.1	5.2
	Services	45.7	4.5	-13.3	-2.0	4.6	4.6
	Oil	19.4	2.1	-10.4	-0.9	2.6	2.2
	Non-oil	80.6	4.4	-10.0	-1.4	4.5	4.6
Agriculture-led transition	Growth	100.0	3.9	-10.0	-1.3	4.2	4.0
	Agriculture	11.0	2.8	-10.3	-1.3	4.8	5.1
	Industry	43.3	5.0	-3.5	-0.5	4.3	4.5
	Services	45.7	4.5	-13.3	-2.0	4.7	4.5
	Oil	19.4	2.1	-10.4	-0.9	2.2	1.3
	Non-oil	80.6	4.4	-10.0	-1.4	4.6	4.6
Industry-led transition	Growth	100.0	3.9	-10.0	-1.3	5.0	5.2
	Agriculture	11.0	2.8	-10.3	-1.3	2.4	1.6
	Industry	43.3	5.0	-3.5	-0.5	6.9	8.0
	Services	45.7	4.5	-13.3	-2.0	5.6	5.6
	Oil	19.4	2.1	-10.4	-0.9	2.2	1.4
	Non-oil	80.6	4.4	-10.0	-1.4	5.6	6.0

Table 3.4—Continued

		Initial	2010	2011	2012	2013–2016	2017–2020
Service-led transition	Growth	100.0	3.9	-10.0	-1.3	5.6	6.3
	Agriculture	11.0	2.8	-10.3	-1.3	3.6	2.5
	Industry	43.3	5.0	-3.5	-0.5	6.8	7.8
	Services	45.7	4.5	-13.3	-2.0	6.6	7.3
	Oil	19.4	2.1	-10.4	-0.9	2.7	3.4
	Non-oil	80.6	4.4	-10.0	-1.4	6.3	6.9
Accelerated transition	Growth	100.0	3.9	-10.0	-1.3	6.7	8.0
	Agriculture	11.0	2.8	-10.3	-1.3	3.9	2.4
	Industry	43.3	5.0	-3.5	-0.5	9.0	10.9
	Services	45.7	4.5	-13.3	-2.0	7.7	8.8
	Oil	19.4	2.1	-10.4	-0.9	2.5	2.8
	Non-oil	80.6	4.4	-10.0	-1.4	7.6	8.9

Source: Yemen dynamic computable general equilibrium model.

Poverty outcomes of alternative transition options range between a national poverty rate of 59.6 percent in the worst-case scenario and 33.6 percent in the best-case scenario by 2020. If no immediate action is taken, poverty is bound to continuously increase after 2011 and may reach close to 60 percent in 2020. Under this scenario, both rural and urban poverty would continue to increase by 7.9 and 11.3 percentage points, respectively, by 2020 compared with the slow transition scenario (see Table C.4). All three sector-led growth scenarios (agriculture, industry, and service) substantially reduce national poverty—by 1.5, 6.9, and 8.5 percentage points by 2020, respectively, compared with the slow transition scenario. Under the accelerated scenario, a combination of growth in all sectors and thus the most optimistic scenario, national poverty can be reduced to less than 34 percent by 2020. In this case, poverty levels would reach their 2009 levels in the year 2015. Urban and rural poverty reduction are the same under the accelerated scenario, mainly because industry-led growth has a substantial spillover effect on the economy, and both the urban and rural poor benefit from such growth. Compared with the slow transition scenario, rural and urban poverty fall under this scenario by around 26 percentage points by 2020: 38 and 23 percent, respectively.

Industry- and agriculture-led growth has the strongest poverty reduction effects in Yemen. Comparing the poverty and growth elasticities (Table 3.5) shows that among the sector-led growth scenarios, industry-led and agriculture-led growth have the strongest poverty-reducing effect. One percent of industry- or agriculture-led growth reduces poverty by 0.6 percentage points, compared with 0.52 under service-led growth. This can mainly be explained by higher returns on factors owned by the poor, especially unskilled labor. Compared with the slow transition scenario, wages for unskilled labor rise by 1.7 percent, 5.3 percent, 12.9 percent, and 25.1 percent under agriculture-led, industry-led, service-led, and accelerated scenarios, respectively, between 2013 and 2020.

Table 3.5—Poverty and nutrition elasticities

	Annual change (percentage points)		Non-oil GDP average per capita growth (percent)	Arc semielasticities	
	2013–2020		2013–2020	2013–2020	2013–2020
	Poverty	Child stunting		Poverty–non-oil growth	Child stunting–non-oil growth
Baseline	-0.61	-0.13	1.44	-0.43	-0.09
Slow transition	-0.82	-0.16	1.51	-0.54	-0.10
Agriculture-led transition	-0.92	-0.14	1.55	-0.60	-0.09
Industry-led transition	-1.70	-0.30	2.83	-0.60	-0.10
Service-led transition	-1.93	-0.43	3.70	-0.52	-0.12
Accelerated transition	-3.09	-0.63	5.47	-0.56	-0.11

Source: Yemen dynamic computable general equilibrium and nutrition models.

Child stunting reduction is much less responsive to growth than poverty reduction. Assuming a constant child stunting–growth semielasticity of 0.139,[12] the reduction in the prevalence of child stunting is driven by the rate of growth generated under the different scenarios. Accordingly, the highest reduction in child stunting is achieved under the accelerated transition scenario. From 2013 to 2020, the rate falls by around 4.3 percentage points to 57.0 percent in 2020, or 0.63 percentage points per year (Table A.3). In other words, accelerated growth is needed to bring down the child stunting rate to the 2005 level, which rose from 2005 to 2013 as a result of the 2007/08 global food, fuel, and financial crisis, and the 2011 uprisings. *Ceteris paribus,* growth under all other scenarios will be insufficient. Given the low child stunting–growth elasticity, nutrition-beneficial investments and targeted nutrition programs are needed, in addition to strong economic growth, to significantly reduce child malnutrition.

Costing Growth Acceleration, Poverty Reduction, and Improvement in Food Security

Costing of Aggregate Sector Spending

Achieving these ambitious growth targets will require additional public spending of between US$5.3 and $11.3 billion[13] over the next eight years, depending on the spending efficiency. Yemen's experience in translating spending into growth outcomes (Table 3.6) and its low ranking in governance indicators may suggest that assuming the less optimistic spending efficiency may be more realistic. Under the low-efficiency scenario, $757 million (6.7 percent) would have to be allocated to agriculture, $6.0 billion (52.9 percent) to industry, and $4.6 billion (40.4 percent) to services. The results make a strong case for improving efficiency and effectiveness of the public sector, which could reap considerable gains in terms of achieving more with the same resources or achieving the same growth outcomes with fewer resources (see next section).

Table 3.6—Public spending and efficiency

	2013–2016	2017–2020	Total	% of total additional spending
Agriculture-led				
Low efficiency	691	67	757	6.7
High efficiency	345	53	399	7.1
Industry (electricity, water, roads, and thel ike)				
Low efficiency	2,351	3,645	5,996	52.9
High efficiency	1,176	1,822	2,998	56.3
Services (communication, transportation, social transfers)				
Low efficiency	1,802	2,776	4,578	40.4
High efficiency	837	1,116	1,953	36.6
TOTAL low efficiency	4,843	6,488	11,331	100.0
TOTAL high efficiency	2,358	2,972	5,330	100.0

Source: Authors' calculations.

To stabilize the economy and bring growth and poverty back to pre-2011 levels, additional financial resources of between $2.4 and $4.8 billion are needed between 2013 and 2016. Assuming that public spending efficiency may not significantly improve in the short term and applying the higher-bound estimate, about $691 million would have to be allocated to the agricultural sector; $2.4 billion to roads, electricity, water, and other infrastructures; and $1.8 billion to transportation, communication, health, education, and social transfers. Both the high- and low-efficiency scenarios suggest that about 7 percent of the total should be invested in agriculture; 54 percent in roads, electricity, water, and other infrastructures; and 39 percent in transportation, communication, health, education, and social transfers.

[12] For the estimation of the elasticity, see Appendix B.
[13] All dollar amounts are in US dollars.

Box 3.1—Petroleum subsidy reform in Yemen

Petroleum subsidies strain public finances, distort markets, and provide only a blunt tool in the fight against poverty. Subsidy-induced distortions lead to misguided price information and ensuing investment decisions, and are likely to slow adaptation of new energy- and water-saving technologies. On the consumer side, it is usually the better-off households that disproportionally benefit most from petroleum subsidies, thus undermining social equity. Therefore, many countries such as Chile, China, Ghana, and Iran have successfully reformed their subsidy programs over the past years.

Yemen also started to reduce its petroleum subsidies before the political crisis in 2010 due to a combination of declining oil revenues and the high fiscal costs of sustaining the subsidy. Before the political crisis, petroleum subsidies in Yemen made up more than 20 percent of the government budget, more than total spending on education, health, and social transfers combined. The rising cost of the fuel subsidy also had an adverse impact on the public investment program in infrastructure, including transportation and telecommunication. Investment for development was largely externally financed (about 2 to 4 percent of GDP). In 2011, spending on petroleum subsidies remained high, at about $3 billion, and it is likely to remain at this level at given prices.

The results of a dynamic computable general equilibrium model support a comprehensive petroleum subsidy reform in Yemen. Yet reforms have to be designed smartly, because phasing out of subsidies without complementary measures may lead to an initial drop in growth and spike in poverty. The reform would create the much-needed fiscal space for the government to finance growth-enhancing measures, such as investments in the utilities, transportation, trade, and construction sectors. Such investments, combined with efficiency gains, are projected to accelerate economic growth between 0.1 and 0.8 percentage points annually. Faster phasing out of subsidies leads to higher growth gains. In addition to investments, targeted social transfers will need to be scaled up to compensate the poorest and most food insecure from the short-term real-income losses.

The combined short- and medium-term effects not only avoid an increase in poverty but also lead to broadened options for pro-poor growth in Yemen. Thus, for the short and medium term, petroleum subsidy reform offers great opportunities to scale up social transfers and to create the platform for a restructuring of productive, industrial, and service value chains, which could be exploited by enabling domestic and foreign private investment.

Source: Breisinger, Engelke and Ecker 2011.

While providing support to Yemen until 2016 clearly takes priority, it is also important to note the longer-term need for additional investments. Sustaining and further accelerating growth and poverty reduction beyond 2016 to 2020 will also require substantial investments of between $3.0 and $6.5 billion. Given this longer-term time horizon and assuming significant improvements in Yemen's governance, it may be realistic to assume an improved spending efficiency for this case, which would mean, under the higher spending efficiency hypothesis, that about an additional $1.8 billion for infrastructure and $1.1 billion for services are required. Apart from improved governance, Yemen should also strive for improving the tax collection system in order to be able to increase domestic sources of funding. Not only would this make Yemen more independent from foreign assistance, but it would also help avoid the *aid curse* that can lead to a slowdown of institutional reform and economic structural change. Continuous high levels of aid inflows bear the risk of an appreciation of the exchange rate (Dutch disease). As a result, export-oriented sectors like agriculture can suffer, and thus the full growth potential remains underexploited because of distorted incentives.

Costing of Selected Investments and Programs

To help translate the aggregate sector-level cost estimates into projects, Table 3.7 presents a selection of cost estimates for investments in the agriculture, trade and transportation, and health and education sectors. These investments specifically tackle issues of lacking water storage capacities for irrigation; poor physical access to local markets, health facilities, and other required services typically available in urban centers; water scarcity and poor hygiene from inappropriate sanitation conditions; lacking electrification and power shortages; insufficient and inadequately equipped health facilities for targeted

nutrition-relevant service provision; and insufficient schools. All listed cost accounts present costs for separate investments, while a joint establishment of several infrastructures is likely to reduce the overall costs due to synergy effects.

Table 3.7—Investment costs for basic infrastructure

Basic infrastructure	Costs (US$)
Agriculture	
Irrigation program[1]	
Water-harvesting reservoir (including open cisterns, closed tanks, spring protection works, fencing, protection walls, sedimentation basins, conveyance canals, water-drawing pipes), average cost per unit	33,700
Trade and transportation	
Road network[1]	
Asphalt main road, per km	70,100
Feeder unpaved road, per km	37,800
Health and education	
Water and sanitation	
Nonmechanized community spring water system, per capita[1]	50
Piped drinking water connection in the house through drinking water network, per capita[2]	6
Piped sewage water connection in the house through sewage network, per capita[2]	19
Combined drinking water and sewage water connection in the house through networks (full coverage, gradual) , per capita[2]	21.5
Electricity[1]	
Community electricity program with generator, per capita	37
Health facilities[3]	
Construction (new), per unit	
Health unit	40,000
Health center	180,000
Rural hospital	860,000
Governorate hospital	3,225,000
Referral hospital	4,000,000
Upgrade and equipping, per unit	
Health unit	27,000
Health center	77,000
Rural hospital	450,000
Governorate hospital	900,000
Referral hospital	2,500,00
Maintenance (annual), per unit	
Health unit	3,350
Health center	12,850
Rural hospital	65,500
Governorate hospital	330,000
Referral hospital	464,000
School[4]	
Construction of classroom, per unit	16,000

Sources: (1) Authors' calculation based on IFAD 2010, specific for Yemen; (2) Hutton and Bartram 2008, for selected Middle Eastern and North African countries; (3) Compernolle 2005, specific for Yemen; (4) Ogawa 2004, specific for Yemen.

Note: Costs are reported as estimated for the year of the study.

Nutrition Interventions

Given the importance of children for Yemen's future socioeconomic development and the low nutrition–growth elasticities, specific and targeted programs for children are needed. Targeted nutrition programs are highly cost-effective (in most cases). The economic costs of malnutrition are substantial. Productivity losses due to malnutrition are estimated at more than 10 percent of lifetime earnings, and at 2 to 3 percent of GDP on average (World Bank 2006). In contrast, the costs for intervention programs aiming to prevent malnutrition are low. For example, the benefit–cost ratio for integrated childcare programs including a nutrition component ranges from 9 to 16; for breastfeeding promotion programs in hospitals, it ranges from 6 to 67 depending on the program's design (Behrman, Alderman, and Hoddinott 2004). Yet there is less agreement that community-based nutrition education, information, and communication (IEC) programs are effective in reducing malnutrition, despite their low unit costs (Bhutta et al. 2008).

Estimating the costs of healthcare programs to treat child malnutrition and associated diseases in Yemen requires assumptions on the number of stunted children in the future. According to the Yemen Household Budget Survey 2005/06, around 57.4 percent of all children aged 0–59 months were at least moderately stunted, and around 33.9 percent were severely stunted (MoPIC and IFPRI 2010). As a result of the 2007/08 global food, fuel, and financial crisis, the prevalence of (moderate) child stunting increased by more than 2 percentage points nationwide (MoPIC and IFPRI 2010), and it is expected that it has further increased recently due to the economic impact of the 2011 civil uprisings. For the period 2012–2020, it is projected that the prevalence of moderate and severe child stunting will fall below the 2005 levels after 2015, assuming average prevalence of around 57.4 percent and 33.9 percent, respectively, held constant throughout the projection period in our calculations (Table 3.8). Given UN population projections (UN DESA 2012), the number of moderately and severely stunted children under 5 years old in 2012 equals 2.47 million and 1.46 million, respectively, and is projected to increase by 0.43 million and 0.21 million until 2020.

Table 3.8—Costs of healthcare programs for treatment of malnutrition in children under five, 2012–2020

	Prevalence of child stunting (percent)	Number of stunted children (million)		Program costs per child (US$)	**Total program costs (million US$)**
		2012	Increase until 2020	2012	**2012–2020**
OPTION 1					
Comprehensive basic health program at primary healthcare level					
Moderately and severely stunted children	57.4	2.467	0.429	13.71	
100% coverage					**38.7**
50% coverage					**19.3**
25% coverage					**9.7**
OPTION 2					
Comprehensive basic health program at primary healthcare level					
Moderately stunted children	23.5	1.011	0.215	13.71	
100% coverage					**15.8**
50% coverage					**7.9**
25% coverage					**4.0**
Treatment of severe malnutrition at hospital level					
Severely stunted children	33.9	1.455	0.213	35.25	
100% coverage					**58.6**
50% coverage					**29.3**
25% coverage					**14.7**

Source: Based on Compernolle 2005; MoPIC and IFPRI 2010; UN DESA 2012; and IMF 2011b.

The costs of treating a malnourished child in a comprehensive basic health program at primary healthcare level in Yemen were estimated at $11.38 per case in 2005, and at $30.28 for specific treatment of severe malnutrition at hospital level (Compernolle 2005).[14] The costs of intervention at primary healthcare level include the components of the World Health Organization's (WHO's) Integrated Management of Childhood Illnesses strategy (as proposed for achieving the respective Millennium Development Goals) that addresses the five major diseases of under-five children (malnutrition, anemia, diarrhea, fever, and acute respiratory infections).[15]

For our calculation, we assume ample health facility capacities and full implementation of the intervention from 2012 onward. The total program costs for admitting all stunted children in the comprehensive basic health program at primary healthcare level (Option 1) add up to only $38.7 million for the period 2012–2020. Even when assuming that all severely stunted children require specific treatment in hospitals (Option 2), the total costs will rise to only $75.5 million in 2012–2020. We expect that such an intervention would not eradicate but could significantly reduce child malnutrition in the considered time period. Child malnutrition largely manifests itself during the so-called 1,000-day period, comprising the time in utero and the first 2 years of life. Growth retardation and other impairments experienced during this period are often irreversible in children's later life. Thus, nutrition interventions should target this window of opportunity, which requires additional health and nutrition programs for pregnant and lactating women and respective financial resources.

[14] We use consumer price inflation rate estimates from the IMF (2011b) to calculate the costs for the period 2012–2020.

[15] The costs include only drugs and supplies (including 30 percent markup) but do aggregate all components of treatment and account for the use of different doses (Compernolle 2005). The cost estimation is based on information from UNICEF and WHO, and confirmed by experts of Yemen's Ministry of Public Health and Population. Our calculation does not include costs for immunization and nutrition IEC campaigns. See Table D.1 in Appendix D.

4. COMPLEMENTARY POLICY AND INSTITUTIONAL REFORM FOR POVERTY REDUCTION AND FOOD SECURITY

Investing in growth acceleration will be the key for Yemen to overcome the deep economic crisis and to reduce poverty and food insecurity. However, scaling up public spending as discussed in previous sections will have to be complemented with significant institutional and policy reform and information campaigns. Policy reforms are urgently needed to (1) create fiscal space with which part of the additional spending can be financed domestically, (2) improve public spending and implementation capacities, and (3) attract private investment to support private sector–led growth. For achieving these goals, several reform options stand out and have been part of previous country development strategies. For example, it is now more urgent than ever to implement the National Food Security Strategy (NFSS), the seven-point action plan of the NFSS, and other national strategies, and to make the following reforms a high priority:

Rethink Energy Subsidies

The Government of Yemen made a first step toward reforming petroleum subsidies by increasing fuel prices in 2010. However, simply phasing out the petroleum subsidy would increase food insecurity because higher fuel prices affect farmers and the urban food insecure most. To stabilize food security during the reform period—and even improve it—the ample budgetary savings from reform should be used to finance a combination of direct transfers and productivity-enhancing investments. Transfer payments alone only curb the rise in food insecurity in the short run, but the addition of public investments in infrastructure (related to utilities, transportation, trade, and construction) fosters food security and sustainable economic growth. The combination of direct transfers and investment is a promising strategy for joining the subsidy reform with the promotion of sustainable development. Transfers, investments, and resulting long-term productivity gains complement each other and lead to reduced food insecurity and poverty (see Box 3.1).

Redynamize the Business Climate

Improving the investment climate often involves political commitment to reform rather than financial resources, which makes it an attractive and low-cost option for accelerating growth, reducing poverty, and improving food security. Table 4.1 shows that there is room for improving the investment climate for private domestic and international investors. Yemen currently ranks 99 out of 183 countries in creating a favorable investment climate; yet several key indicators are significantly below the international average. While Yemen ranks high in its favorability for starting a business and dealing with construction permits, improvements are needed in access to credit, investor protection, and tax requirements in order to unleash private sector–driven growth, especially in promising sectors. It is important to note that in order to be pro-poor and pro–food insecure in the long run, growth needs to be both socially and environmentally sustainable. Social sustainability means that benefits from growth need to be shared widely among the population. Environmental sustainability is especially important for Yemen given its fragile natural resource base, especially water and land.[16]

[16] The paragraphs on investment climate, public spending efficiency, and oil subsidies are based on the National Food Security Strategy (NFSS). See the seven-point action plan here: http://www.ifpri.org/sites/default/files/publications/yemennote1en.pdf.

Table 4.1—Yemen investment climate indicators (ranking among 183 countries), 2012

Ease of doing business	**99**
Starting a business	66
Dealing with construction permits	35
Getting electricity	52
Registering property	55
Getting credit	159
Protecting investors	133
Paying taxes	116
Trading across borders	118
Enforcing contracts	38
Resolving insolvency	114

Source: World Bank 2012.

Reduce Qat Production and Consumption

A substantial tax on qat could yield triple benefits, including additional tax revenues, water availability for nonqat agricultural growth, and health benefits to the people. Agriculture, which can make an important contribution to rural development and food security, is constrained by the lack of water; water scarcity and contamination threaten the health of many households. And in all of this, qat emerges as the major culprit, consuming more than 40 percent of Yemen's water supply. Thus, sharply reducing qat consumption is vital for avoiding drought, achieving nonqat agricultural growth, and meeting Yemen's food security goals. However, measures to reduce qat consumption may meet sharp resistance from the Yemeni people. Policy measures will require a communication campaign to provide comprehensive information on their necessity and urgency. The benefits of a qat tax will outweigh the difficulties of implementation: It is likely to discourage people from excessive consumption, allow Yemen to use its water supply more effectively, and generate additional revenue for the government—all of which make the population more food secure. The tax revenue should be invested in agriculture and water infrastructure, and used for the promotion of alternatives to qat production, such as cereal and coffee production, and processing of agricultural products.

Improve Food Security Risk Management And Make Food Imports More Competitive

Yemen is very vulnerable to global food price shocks and disasters, so the country must develop appropriate risk management mechanisms. First, the cereal import market must be made more competitive. Currently, the market is dominated by a small number of importers, which increases local cereal prices even in relatively stable economic circumstances. Appropriate laws and regulations that increase competitiveness will make an important contribution to improving food security. Second, the government should hedge against extreme price fluctuations caused by emergency situations such as the 2007/08 global food crisis. This can be achieved through national grain reserves, regional grain reserves, or hedging in international markets. For any type of price risk management, an effective market price monitoring system will be critical for effective decisionmaking. Third, the government should recognize the role of social transfers in building economic resilience among vulnerable communities. Social transfers can include direct transfers, cash-for-work programs, community asset building through public works, assistance in starting microenterprises, and nutrition and health programs. The government should use the political opportunities that arise from food price crises and disasters to incorporate risk management into the overall economic development planning framework. Strong collaboration among governmental agencies, the private sector, and Yemen's international partners is absolutely essential for success.

Implement the National Water Strategy

Water tables are quickly falling, and water quality and accessibility are substandard. Water sector reform is crucial for achieving the country's food security goals and sustaining accelerated development. Yemen's future food security depends heavily on reducing overall groundwater use and redistributing water used for agriculture to more promising economic activities and human consumption. Important steps toward efficient and sustainable water management are (1) strengthening capacity for and implementation of integrated water resources management, including groundwater monitoring and control, and improved water quality; (2) managing environmental impacts, including promoting environmental protection and building partnerships with the private sector on effluent and waste water; (3) developing water-resource and water-use efficiency by protecting user rights; (4) delivering efficient, low-cost projects on a demand-driven basis by enhancing the efficiency of project implementation, improving coordination, and decentralizing; (5) strengthening institutions to allow them to play their role in promoting efficient water use; and (6) enhancing resource sustainability and quality through improved watershed management.

Target Public Investment and Improve Service Provision

In recent years, Yemen has underspent on infrastructure, agriculture, and health. From a spatial perspective, public spending across governorates does not seem to be aligned with poverty and food security levels, indicating a lack of efficiency and targeting. A comprehensive public investment review must be conducted to better align public investments with Yemen's development objectives in general and its food security strategy in particular across sectors and governorates. Once the right amount of money is being directed to the places that need it most, the government must focus on how the money is being used. Often, physical infrastructure exists but the services provided are not satisfactory. Evaluation and monitoring of service provision quality and investment efficiency in all sectors will thus be needed for better outcomes. However, additional investment is also required, particularly to upgrade the rural drinking water supply and rural roads. Key services to target include programs related to education, nutrition, and family planning.

Launch High-Level National Awareness Campaigns and Leverage the Policy Dialogue with Civil Society

The Yemeni government should launch three national campaigns at the highest political level (for example, as "presidential campaigns"). First, a national family planning program should be implemented. Such a program should be strongly integrated with primary healthcare and should involve religious leaders. Second, a high-level campaign should be launched to address the lack of nutrition and health knowledge among Yemenis. This nutritional education program should cover a wide range of topics, including dietary diversity and micronutrient malnutrition. Third, a campaign should focus on the acceleration of women's empowerment. The evidence clearly shows that gender inequality goes hand in hand with malnutrition. The campaign should focus on improving women's educational attainment, economic participation, health status, and political empowerment. The design of these programs, like all other policy making processes, should increasingly include civil society groups to assure their maximum impact and outreach.

APPENDIX A: CONFLICT AND FOOD INSECURITY

Table A.1—Correlation between conflict and food insecurity

	Correlation coefficients	
Total	0.224	***
Sana'a (urban)	0.192	***
Amran (rural)	0.156	***
Al-Hodeidah (urban)	0.385	***

Source: Based on UNICEF 2012.

Notes: ***, **, * coefficient is statistically significant at the 1 percent, 5 percent, and 10 percent level, respectively.

The percentages of households with children afraid of playing outside (that is, proxy variable for direct exposure to conflict) and with a hungry family member (that is, proxy variable for household food insecurity) are based on the following questions (addressed to the children's caregiver):

"During the past two weeks have you or any family member experienced going to bed hungry due to lack of food?"—"Yes."

"During the past two weeks has any child become afraid of playing outside?"—"Yes."

Table A.2—Relationship between conflict and food insecurity—fixed-effects logit model results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Household insecurity	1.762 ***			1.795 ***	1.100 ***	1.564 ***	1.985 ***	0.979 ***
	0.212			0.233	0.233	0.233	0.249	0.257
Lagged, t-1		0.373 *		-0.058				
		0.224		0.253				
Lagged, t-2			0.118					
			0.250					
Neighborhood insecurity					3.399 ***			3.584 ***
					0.484			0.578
Lagged, t-1						1.556 ***		-0.398
						0.555		0.632
Lagged, t-2							-1.300 *	
							0.677	
Round	-0.044 **	0.043 **	0.109 ***	0.020	-0.081 ***	0.013	0.084 ***	-0.021
	0.019	0.021	0.025	0.022	0.020	0.022	0.027	0.024
Log likelihood	-417.0	-379.7	-322.6	-344.3	-392.2	-344.5	-283.6	-325.4
Observations	1,303	1,093	973	1,087	1,303	1,093	966	1,093
Groups	95	85	82	85	95	86	81	86

Source: Based on UNICEF 2012.

Notes: ***, **, * coefficient is statistically significant at the 1 percent, 5 percent, and 10 percent level, respectively.

The percentages of households with children afraid of playing outside (that is, proxy variable for direct exposure to conflict) and with a hungry family member (that is, proxy variable for household food insecurity) are based on the following questions (addressed to the children's caregiver):

"During the past two weeks have you or any family member experienced going to bed hungry due to lack of food?"—"Yes."

"During the past two weeks has any child become afraid of playing outside?"—"Yes."

APPENDIX B: MODELS AND METHODOLOGY USED

The models described in the following are used to evaluate alternative future scenarios that essentially try to capture the central conditions for economic growth, poverty reduction, and reduction in child malnutrition.

Yemen Dynamic Computable General Equilibrium Model

Table B.1 presents the equations of a simple dynamic computable general equilibrium (DCGE) model illustrating how changes in economic output affect employment and household incomes.[17] Producers of each commodity c produce a level of output Q by employing the factors of production F under constant returns to scale (exogenous productivity α) and fixed production technologies (fixed factor input shares δ) (see equation [1]). In the case of Yemen, there are 12 agricultural activities and commodity sectors, 9 industry sectors, and 4 service sectors. In order to provide a deeper analysis, agricultural activities were spatially disaggregated into the 4 regions: the highlands, the Red Sea and the Tihama, the Arabian Sea, and the internal plateau and desert (all except for coffee and fisheries, which are grown in only 2 zones). Furthermore, the 12 agricultural production activities are regionally split into livestock (4), fishery (4), forestry (1), and crop production activities (34), where all agricultural production activities are specific to each agroecological zone. Other production sectors and commodities included in the model are mining, including oil and gas (1); food processing (1); and light manufactures and other manufactures (1). Electricity and water appear as 2 separate sectors. Services include trade and transportation, other private services, social services, and other public services.[18]

The Yemen DCGE model includes three main factors of production: labor, capital, and land. Labor is disaggregated into unskilled, semiskilled, and skilled labor for both the private and public sectors. To capture their distinctive natures, capital is split into capital that is specific to the oil and gas sector and capital that freely moves across all other sectors of the economy. Within the DCGE model, profit maximization implies that factor payments W are equal to average production revenues (equation [2]). Total labor, land, and capital supply s are fixed, implying full employment and intersectoral mobility (equation [10]), and land is assumed to be agroecological-zone specific, thus giving us four factors of land, one for each region in the model. Consequently, declining farm/factory production causes factor demand to fall, which in turn lowers economywide factor returns and affects production in other sectors as well.

[17] The model description draws on Breisinger, Ecker, and Engelke (2011), and Thurlow and colleagues (2010).

[18] For a detailed list of production activities and commodities, factors of production, household types, and other accounts of the social accounting matrix, see Table C.2.

Table B.1—Mathematical presentation of the dynamic computable general equilibrium model—core model equations

Production function	$Q_{ct} = \alpha_{ct} \cdot \prod_f F_{fct}^{\delta fc}$		(1)
Factor payments	$W_{ft} \cdot \sum_c F_{fct} = \sum_c \delta_{fc} \cdot P_{ct} \cdot Q_{ct}$		(2)
Import supply	$P_{ct} \le E_t \cdot W_c^m \perp M_{ct} \ge 0$		(3)
Export demand	$P_{ct} \ge E_t \cdot W_c^e \perp X_{ct} \ge 0$		(4)
Household income	$Y_{ht} = \sum_{fc} \theta_{hf} \cdot W_{ft} \cdot F_{fct} + r_h \cdot E_t$		(5)
Consumption demand	$P_{ct} \cdot D_{hct} = \beta_{hc} \cdot (1 - v_h) \cdot Y_{ht}$		(6)
Investment demand	$P_{ct} \cdot I_{ct} = \rho_c \cdot \left(\sum_h \upsilon_h \cdot Y_{ht} + E_t b \right)$		(7)
Current account balance	$w_c^m \cdot M_{ct} = w_c^e \cdot X_{ct} + \sum_h r_h + b$		(8)
Product market equilibrium	$Q_{ct} + M_{ct} = \sum_h D_{hct} + I_{ct} + X_{ct}$		(9)
Factor market equilibrium	$\sum_c F_{fct} = s_{ft}$		(10)
Land and labor expansion	$s_{ft} = s_{t-1} \cdot (1 + \varphi_f)$	*f* is land and labor	(11)
Capital accumulation	$s_{ft} = s_{t-1} \cdot (1 - \eta) + \sum_c \frac{P_{ct-1} \cdot I_{ct-1}}{k}$	*f* is capital	(12)
Technical change	$\alpha_{ct} = \alpha_{ct-1} \cdot (1 + y_c)$		(13)

Notes:

Subscripts

- Commodities or economic sectors
- Factor groups (land, labor, and capital)
- Household groups
- Time periods

Endogenous variables

- Household consumption demand quantity
- Exchange (local/foreign currency units)
- Factor demand quantity
- Investment demand quantity
- Import supply quantity
- Commodity price
- Output quantity
- Average factor return
- Export demand quantity
- Total household income

Exogenous variables

b	Foreign savings balance (foreign currency units)
r	Foreign remittances
s	Total factor supply
w	World import and export prices

Exogenous parameters

α	Production shift parameter (factor productivity)
β	Household average budget share
γ	Hicks neutral rate of technical change
δ	Factor input share parameter
η	Capital depreciation rate
θ	Household share of factor income
κ	Base price per unit of capital stock
ρ	Investment commodity expenditure share
υ	Household marginal propensity to save
φ	Land and labor supply growth rate

Source: Thurlow 2004.

Foreign trade is determined by comparing domestic and world prices, where the latter are fixed under a small country assumption. The simple model implements trade as a complementarity problem. If domestic prices exceed world import prices w^m (adjusted by exchange rate E), then the quantity of imports M increases (equation [3]). Conversely, if domestic prices fall below world export prices w^e, then export demand X increases (equation [4]), and to capture that relationship, the Yemen model uses an Armington elasticity of 4 and an export transformation elasticity of 2. To ensure macroeconomic consistency, a flexible real exchange rate adjusts to maintain a fixed current account balance b (measured in foreign currency units) (equation [8]). Total factor productivity (TFP) growth determines the growth of gross domestic product (GDP), the macroeconomy, and the interactions between the economy's agents of production and consumption. If a negative shock should occur, for example in this case of Yemen a conflict situation, TFP growth will be negative. The negative growth shock is translated into reduced sectoral production, reductions in the use of factors of production, and through the model's linkages, impacts on factor income and household income, possibly falling exports, and possibly rising imports.

Factor incomes are distributed to households using fixed income shares θ based on households' initial factor endowments and are combined with foreign remittances r adjusted by the exchange rate (equation [5]). Incomes Y are then saved (based on marginal propensities to save υ) or spent on consumption C (according to marginal budget shares β) (equation [6]). The budget shares were calculated using detailed sectoral data from the Central Statistics Organization and the latest Household Budget Survey (HBS 2005/2006) for Yemen. Household income elasticities were econometrically estimated using a semilog inverse function suggested by King and Byerlee (1978) and based Yemen's HBS 2005/2006 for rural and urban households separately. These elasticities range from, for example, 0.31 for cereals to 2.2 for transportation and 1.95 for fuel, with urban household elasticities tending to be lower than their rural counterparts.

Household savings and foreign capital inflows are collected in a national savings pool from which investment demand I is financed (that is, a savings-driven investment closure) (equation [7]). Finally, prices P equilibrate product markets such that demand for each commodity equals supply (equation [8]). The model thereby links production and trade to household incomes via changes in market prices, employment, and factor returns. Thus if production falls, two mechanisms work together: Factor income will fall as a result of reduced factor demand, at the same time that supply falls, leading to an increase in prices, which in turn raises consumption expenditure and, in addition to reduced income from factors, reduces demand, which may then reduce prices. The interactions between all the agents used in the model will eventually reach a stable equilibrium where, depending on the relationships specified, reduced output, wages, demand, and ultimately GDP may be the result.

The model's variables and parameters are calibrated to empirical data from a social accounting matrix (SAM) that captures the initial structure of Yemen's economy in 2009. The 2009 SAM is updated from the 2007 Yemen SAM using various national and international datasets. For the agricultural sector, all the detailed data rely upon the 2011 *Agricultural Yearbook* from the Ministry of Agriculture and Irrigation. The data sources above have been complemented with the most recent data from the International Monetary Fund, the World Bank, and the United Nations Conference on Trade and Development (UNCTAD). For example, the SAM is fully consistent with GDP at market prices as provided by the IMF:

GDP = C + I + G + (X - M)
Private consumption (C) = Yemeni rials (YRL) 4.25 billion
Public consumption (G) = YRL 0.75 billion
Investment (I) = YRL 0.69 billion
Net exports (X - M) = YRL -0.59 billion
GDP = YRL 5.10 billion

After the calibration, the parameters are then adjusted over time to reflect demographic and economic trends, and the model is re-solved for a new equilibrium each year. The model is recursively dynamic, with the dynamics occurring from 2010 to 2020. Between periods the model is updated to

reflect exogenous rates of labor expansion φ (equation [11]). The rate of capital accumulation is determined endogenously, with previous period investment converted into new capital stocks using a fixed capital price κ (equation [12]). This is added to previous capital stocks after applying a depreciation rate π. Finally, the model captures TFP through the production function's shift parameter α, with the rate of technical change γ determined exogenously. Changes in TFP are the main driver of changes in output for the simulations conducted in this paper.

Microsimulations

Poverty

The DCGE model links to a microsimulation model, which allows for the endogenous estimation of changes in economic output on poverty. All HBS sample households are included in the microsimulation model, and their total expenditures are linked to each of the eight representative households included in the DCGE model according to their rural/urban and zonal locations. The linkages between the DCGE and microsimulation models allow for the analysis of microimpact of the changes in representative households' consumption induced by changes in their real expenditures. The endogenous changes derived from the DCGE model for the respective household groups are used to recalculate consumption expenditures of their corresponding households in the survey dataset. New levels of total consumption expenditures are recalculated based on individual households' budgets, and the new poverty rates for each region, rural and urban, and the national total are obtained by comparing expenditure levels (in real terms) with the official poverty line defined for the HBS.

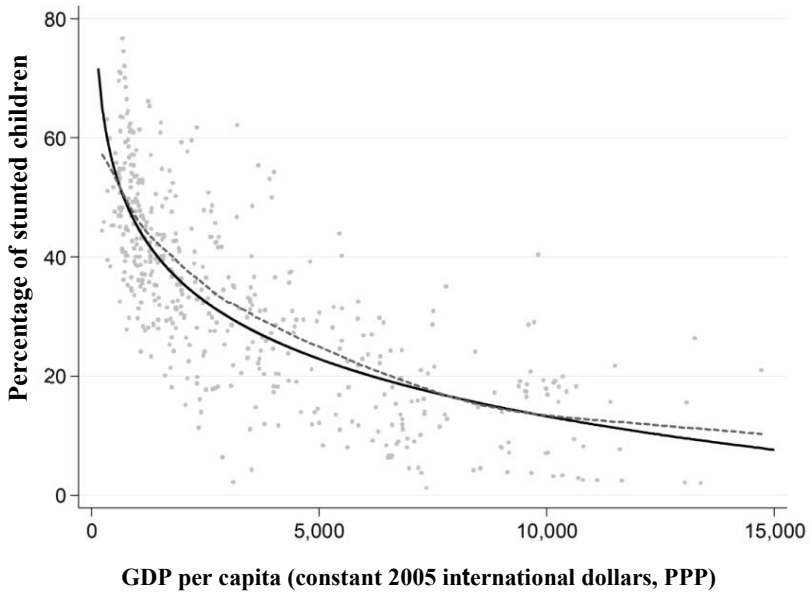
Nutrition

The prevalence of stunting in children under five years of age is chosen as an indicator to measure the nutritional impact of economic growth under different policy scenarios for the period 2012–2020.[19] To translate economic growth as projected by the DCGE model, we estimate elasticities that translate changes in GDP into changes in the prevalence of malnutrition. GDP growth elasticities with respect to the prevalence of malnutrition are directly derived from cross-country estimations that fit time series data of GDP levels and malnutrition rates such as those available from the World Bank's World Development Indicators (WDI) database (World Bank 2012). Following this approach, we estimate the prevalence of child stunting in a country as a function of the country's GDP per capita using a nonparametric regression to explore the relationship between the variables, and we then choose a functional form that best fits this relationship in the data. Specifically, we apply a locally weighted regression on the data from all low- and middle-income countries (with available observations), using STATA's locally weighted scatterplot smoothing (LOWESS) command. Given the shape of the curve, we apply a fractional polynomial regression of degree 1 on the data and let the data determine the specific functional form and respective parameter estimates (Figure B.1).[20]

[19] There are five reasons to support this choice: First, young children's nutritional status tends to be the most responsive to changes in living conditions and to be vulnerable to food insecurity. Second, and closely related to the first, protein–energy deficiency and micronutrient deficiencies are usually most prevalent among young children. Third, anthropometric measures capture the nutrition outcomes of inadequate food intake in terms of macro- and micronutrients, adverse health conditions, and the interaction of both. Fourth, of the three most common child anthropometric measures, height-for-age (identifying stunting), because it best reflects the cumulative effects of chronic undernutrition and persistent disease burden, is a good overall, long-run nutrition indicator. Fifth, by focusing on young children, who are often the weakest individuals in the household, we capture aspects of unequal intrahousehold distribution of resources that are ignored when looking at household-level indicators.

[20] Thus, we do not control for other country-specific factors such as income distribution, literacy or school enrollment rate, vaccination rate, and water and sanitation network coverage, which may systematically change in the course of economic growth and affect nutrition outcomes.

Figure B.1—Relationship between child stunting prevalence and GDP per capita in low- and middle-income countries



Source: Based on WDI database (2012).

Note: The chosen bandwidth of the locally weighted polynomial regression curve is 0.8 (that is STATA's standard bandwidth). The data are fitted by locally weighted polynomial regression (dashed line) and fractional polynomial regressions of degree 1 (solid line). PPP = purchasing power parity.

The fractional polynomial regression shows that the specification of the functional form with best statistical fit of the data has GDP per capita in logarithmic form and is defined as

$$Stunt = b_0 + b_1 * \left[ln\left(GDP_{pc}\right) + b_2\right] + \varepsilon, \quad \text{(B.1)}$$

where *Stunt* is the prevalence of child stunting in percentage; GDP_{pc}, the GDP per capita level, normalized by 10,000; b_0, b_1, and b_3, the coefficients to be estimated; and ε, an error term. Per capita GDP is measured in constant 2005 international dollars at purchasing power parity. The sample of low- and middle-income countries contains observations from 123 countries for different years between 1980 and 2009. The regression results suggest that 1 percent of GDP growth per capita reduces the prevalence of child stunting by 0.139 percentage points on average in the long run (Table B.2).

Table B.2—Regression results

	All countries	More effective countries	Less effective countries
Coefficient (standard error)			
b_0	27.87	35.04	20.18
	0.53	0.55	0.43
b_1	**-13.90**	-14.56	-13.79
	0.53	0.57	0.42
b_2	1.052	1.035	1.069
F-value	685.8	659.0	1,073.8
R-square	0.593	0.734	0.824
Adjusted R-square	0.593	0.733	0.824
Observations	472	241	231

Source: Based on World Development Indicators database (WB 2012).

To test the sensitivity of this semielasticity estimate, we divide the total sample into two subsamples and run the fractional polynomial regression of degree for each subsample. We separate countries based on their effectiveness in translating growth into reduction of child stunting.[21] Intercountry differences may be due to the structure of growth, distribution policies, more and more-effective nutrition-beneficial investments, and so on. The subsample of more effective countries includes observations from 68 countries, and the subsample of less effective countries includes observations from 55 countries. The specifications of the functional form with best statistical fit for the subsamples are identical with the functional form for the total sample (though the coefficient estimates differ, of course). In more effective countries, the average child stunting reduction resulting from a GDP per capita increase of 1 percent equals 0.146 percentage points, and 0.138 percentage points in less effective countries (Table B.2). Thus, the semielasticities for less effective countries and for all countries are very similar. Given that Yemen belongs to the less effective countries according to our classification, but reforms toward more effective use of available resources are generally assumed under our transition scenarios, we use the overall semielasticity (-0.139) for all of our projections.

[21] The effectiveness of a country is considered as above (below) average if the sum of the deviations of the observed values from the predicted value is negative (positive).

APPENDIX C: SUPPLEMENTARY DCGE MODEL TABLES

Table C.1—Macro-SAM for Yemen (billions Yemeni Rials), 2009

	Activity	Commodity	Factors	House-holds	Govern-ment	ROW	S-I	Direct Tax	Import Tax	Commodity Tax	Total
Activity		8.369									8.369
Commodity	3.056			4.246	0.752	1.439	0.691				10.183
Factors	5.313										5.313
Households			5.313	0.533	-0.596	0.096					5.345
Government						0.078		0.213	0.057	-0.271	0.077
ROW		2.029									2.029
S-I				0.354	-0.079	0.416					0.691
Direct Tax				0.213							0.213
Import Tax		0.057									0.057
Commodity Tax		-0.271									-0.271
Total	8.369	10.183	5.313	5.345	0.077	2.029	0.691	0.213	0.057	-0.271	

Source: Yemen dynamic computable general equilibrium model.

Notes: SAM = social accounting matrix, ROW = rest of the world, S-I = savings and investment.

Table C.2—Social accounting matrix disaggregation

Activities:	**Activities cont'd:**	**Commodities cont'd:**	**Factors cont'd:**
Wheat 1	Livestock 1	Other mining	Public sector, skilled
Wheat 2	Livestock 2	Food processing	Profit
Wheat 3	Livestock 3	Light manufacturing	Oil sector profit
Wheat 4	Livestock 4	Oil refinery	Land 1
Sorghum and millet 1	Fishery 2	Other manufacturing	Land 2
Sorghum and millet 2	Fishery 3	Electricity	Land 3
Sorghum and millet 3	Forestry	Water	Land 4
Sorghum and millet 4	Oil and gas	Construction	**Households:**
Other cereals 1	Other mining	Trade and transportation	Rural households in region 1
Other cereals 2	Food processing	Other private services	Urban households in region 1
Other cereals 3	Light manufacturing	Social services	Rural households in region 2
Other cereals 4	Oil refinery	Other public services	Urban households in region 2
Fruits 1	Other manufacturing	Livestock	Rural households in region 3
Fruits 2	Electricity	Fishery	Urban households in region 3
Fruits 3	Water	Forestry	Rural households in region 4
Fruits 4	Construction	Oil and gas	Urban households in region 4
Vegetables 1	Trade and transportation	Other mining	**Other agents**
Vegetables 2	Other private services	Food processing	Enterprises
Vegetables 3	Social services	Light manufacturing	Government
Vegetables 4	Other public services	Oil refinery	Rest of the world
Pulses and oilseeds 1	**Commodities:**	Other manufacturing	**Savings and investments:**
Pulses and oilseeds 2	Wheat	Electricity	**Taxes:**
Pulses and oilseeds 3	Sorghum and millet	Water	Direct tax
Pulses and oilseeds 4	Other cereals	Construction	Commodity tax
Coffee 1	Fruits	Trade and transportation	Import tax
Coffee 2	Vegetables	Other private services	
Other export crops 1	Pulses and oilseeds	Social services	
Other export crops 2	Coffee	Other public services	
Other export crops 3	Other export crops	**Factors:**	
Other export crops 4	Qat	Private sector, unskilled	
Qat 1	Livestock	Private sector, semiskilled	
Qat 2	Fishery	Private sector, skilled	
Qat 3	Forestry	Public sector, unskilled	
Qat 4	Oil and gas	Public sector, semiskilled	

Source: Yemen dynamic computable general equilibrium model.

Table C.3—Overview of scenario assumptions

	Annual growth rate (change from previous year in percent)						
	TFP			Government consumption	Transfers to households	Remittances	Population and labor force
	Agriculture	*Industry*	*Services*				
Base	0	2	2	4	4	4	3
Conflict 2011							
Stagnation	-12	-12	-12	-12	-23	-9	3
Slow transition	-12	-12	-12	-12	-23	-9	3
Agriculture-led transition	-12	-12	-12	-12	-23	-9	3
Industry-led transition	-12	-12	-12	-12	-23	-9	3
Service-led transition	-12	-12	-12	-12	-23	-9	3
Accelerated transition	-12	-12	-12	-12	-23	-9	3
Transition 2012							
Stagnation	-4	-4	-4	-2	20	11	3
Slow transition	-4	-4	-4	-2	20	11	3
Agriculture-led transition	-4	-4	-4	-2	20	11	3
Industry-led transition	-4	-4	-4	-2	20	11	3
Service-led transition	-4	-4	-4	-2	20	11	3
Accelerated transition	-4	-4	-4	-2	20	11	3
Transition 2013-2020							
Stagnation	0	0	0	0	0	0	3
Slow transition	0	2	2	4	4	4	3
Agriculture-led transition	1	2	2	4-5(* + #)	4-28 ++	2-6 +++	3
Industry-led transition	0	3-6 *	2	4-5(* + #)	4-28 ++	2-6 +++	3
Service-led transition	0	2	3-6 **	4-5(* + #)	4-28 ++	2-6 +++	3
Accelerated transition	1	3-6 *	3-6 **	4-5(* + #)	4-28 ++	2-6 +++	3

Source: Government of Yemen and JSEA Staff.

Notes: * TFP for the industry sector is assumed to grow at 3 percent in 2013 after which it grows at 6 percent for the remainder of the period

** TFP for the services sector is assumed to grow 3 percent in 2013 after which it grows at 6 percent for the remainder of the period.

+ The annual growth in government consumption increases from 4 percent in 2013 to 5 percent in 2014 and 2015 and goes back to 4 percent from 2016-2020.

++ The annual growth in households' transfers is 28 percent in 2013, falls down to 5 percent in 2014 and 2015 and then reverts to a growth rate of 4 percent till 2020.

+++ The annual growth in household remittances is 2 percent in 2013, rises to 6 percent p.a. in 2014 and 2015 and finally becomes 4 percent till 2020.

Annual growth rises from 4 percent in 2013 to 5 percent in 2014 and 2015 and falls back to a 4 percent growth for the remainder of the period.

Table C.4—Detailed poverty results

		Initial (2009)	2010	2011	2012	2016	2020
BASE	National	42.8	42.3	41.8	41.3	38.8	36.3
	Rural	47.6	47.3	46.9	46.5	44.0	41.5
	Urban	29.9	29.2	28.5	27.6	25.1	22.5
STAGNATION	National	42.8	42.3	54.4	57.3	58.7	59.6
	Rural	47.6	47.3	59.0	61.8	63.0	63.8
	Urban	29.9	29.2	42.4	45.3	47.5	48.7
Slow transition	National	42.8	42.3	54.4	57.3	54.0	50.8
	Rural	47.6	47.3	59.0	61.8	58.7	55.9
	Urban	29.9	29.2	42.4	45.3	41.4	37.4
Agriculture-led transition	National	42.8	42.3	54.4	57.3	52.5	49.3
	Rural	47.6	47.3	59.0	61.8	57.4	54.5
	Urban	29.9	29.2	42.4	45.3	39.6	35.7
Industry-led transition	National	42.8	42.3	54.4	57.3	50.6	43.9
	Rural	47.6	47.3	59.0	61.8	55.4	48.4
	Urban	29.9	29.2	42.4	45.3	37.7	32.0
Service-led transition	National	42.8	42.3	54.4	57.3	50.6	42.3
	Rural	47.6	47.3	59.0	61.8	55.6	47.4
	Urban	29.9	29.2	42.4	45.3	37.3	28.9
Accelerated transition	National	42.8	42.3	54.4	57.3	46.8	33.9
	Rural	47.6	47.3	59.0	61.8	51.5	38.1
	Urban	29.9	29.2	42.4	45.3	34.3	22.7

Source: Yemen dynamic computable general equilibrium model.

APPENDIX D: COSTS OF INVESTMENTS

Table D.1—Health program costs for treatment of malnourished children aged 0–5 years, at 2005 prices

HOSPITAL LEVEL	
Severe malnutrition	**30.28**
PRIMARY HEALTHCARE LEVEL	
CHILDREN BETWEEN 2 MONTHS AND 5 YEARS	
Acute respiratory infections	
Severe pneumonia or very severe disease	0.15
Pneumonia	0.17
Cough or cold—mother counseling	
Diarrhea	
Severe dehydration	1.39
Some dehydration	0.23
No dehydration	0.16
Severe persistent diarrhea	1.35
Persistent diarrhea	0.16
Dysentery	0.18
Fever	
Very severe febrile disease	0.43
Fever—malaria unlikely	0.02
Severe complicated measles	1.14
Measles with eye or mouth complications	1.07
Measles	0.06
Ear Problems	
Mastoiditis	0.16
Acute ear infection	0.17
Chronic ear infection—mother counseling	
Malnutrition	
Severe malnutrition (pre-referral)	0.06
Very low weight	4.00
Anemia	
Severe anemia (pre-referral)	0.06
Anemia	1.00
INFANTS UNDER 2 MONTHS	
Bacterial infection	
Possible serious bacterial infection (pre-referral)	0.48
Local bacterial infection	0.70
Diarrhea	
Severe dehydration	0.75
Some dehydration	0.23
No dehydration	0.16
Severe persistent diarrhea	0.75
Dysentery	0.05
Feeding problem or low weight	
Not able to feed (pre-referral)	0.48
Feeding problem or low weight	3.00
TOTAL	**11.78**

Source: Compernolle (2005).

Note: Costs are reported in US$ per case and as estimated for the year of the study.

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