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Implications of Productivity Growth in Pakistan:

An Economy-Wide Analysis

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Public investments and policies under Pakistan's new Framework for Economic Growth are expected to lead to substantial gains in productivity, especially in the industrial and service sectors of Pakistan's economy. Computable General Equilibrium (CGE) model simulations using a new 2008 Social Accounting Matrix (SAM) for Pakistan show that achieving high productivity growth targets broadly consistent with the Framework for Economic Growth would imply a 9.3 percent per year gain in average household income (compared to trend growth in household incomes of 5.8 percent). Accelerating agricultural growth as well, however, would result in even greater overall economic growth with an additional 2.6 percent gain in average household income. Moreover, with accelerated agriculture growth, real incomes of poor household groups rise substantially, by an additional 2.9 to 4.5 percent, as food-deficit urban poor and poor rural non-farm households benefit from lower real food prices, and agricultural growth spurs rural non-farm output and incomes.

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1. INTRODUCTION

Pakistan's new Framework for Economic Growth (Pakistan, Planning Commission 2011) emphasizes a need to increase productivity through improving quality of governance, developing vibrant markets, promoting creative cities, and energizing youth and communities. The emphasis is not on physical ("brick and mortar") investments, but on institutions, soft investments including education and health, and easing constraints to growth such as inadequate market development and inefficient government. Nonetheless, even though much of the focus is on institutions and policies that cut across the entire economy, the Framework does identify major productivity gaps in the agricultural, industrial, and service sectors. Reducing these gaps, and thereby increasing sectoral productivity, could result in substantially accelerated economic growth.

Increases in sectoral productivity imply major shifts in economic structure and the distribution of incomes across space and across households, particularly if productivity gains are not equal across sectors. Indeed, Pakistan already has been experiencing such shifts over the past several decades. As in most other countries that have experienced sustained economic growth, the share of agriculture in total output (value-added) in Pakistan's economy has fallen over time, from 41 percent in the 1960s, to 25 percent in the 1990s, to 21.5 percent in 2010–11. Concurrently, the shares of industry and services have increased to 25.2 and 53.3 percent, respectively. It is important to note, however, that this decline in agriculture's share has occurred in spite of significant growth in agricultural output. Real agricultural GDP increased by 4.4 percent from 1990 to 2000 and by 3.4 percent from 2000 to 2010, (1.9 and 1.2 percent, respectively, in per capita terms).

Looking forward, public investments and policies under the Framework for Economic Growth are expected to lead to substantial gains in productivity for industry and services in Pakistan's economy. Assuming these productivity gains are achieved, what are the implications for overall economic growth and welfare of various household groups? Equally relevant is the question of what would be the additional gains if substantial productivity growth in the agricultural sector (for which productivity growth has slowed in recent years) is also achieved. This issue of accelerating agricultural growth is particularly important given the large percentage of Pakistan's poor that reside in rural areas.

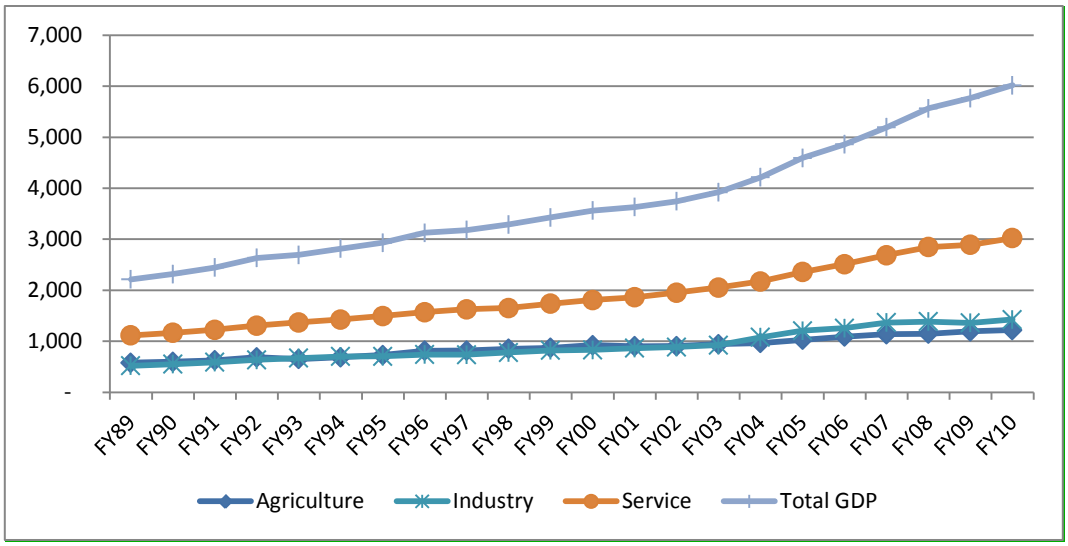
This paper examines these issues using a computable general equilibrium (CGE) model based on a newly constructed Social Accounting Matrix of the Pakistan economy for 2007–08. The simulations presented here show the effects of increased exogenous total factor productivity growth in various sectors of the Pakistan economy. We do not model the source of this productivity growth in the agricultural sector (such as investments in agricultural research and extension, increased use of improved seeds, and inputs) or in non-agricultural sectors (such as technical change, improved management, and agglomeration economies due to well-functioning cities). Instead, our focus is on the effects of these productivity changes on other sectors of the economy (spillover effects) and on household incomes. By comparing simulations of accelerated non-agricultural growth and accelerated overall growth, the paper sheds light on the potential benefits of achieving productivity growth targets broadly consistent with the Framework for Economic Growth and a broader economic growth that includes substantial agricultural productivity growth.

The paper is organized as follows. Section two presents a brief overview of recent growth trends across sectors in Pakistan's economy. Section three highlights the key features of the Pakistan economy and the Social Accounting Matrix that serves as the data base for the model. This section also includes a brief description of the equations and behavioral parameters of the model itself. The fourth section describes the productivity growth simulations and summarizes the effects from the alternative scenarios on aggregate and sectoral GDP growth. Section five summarizes and presents concluding observations.

2. RECENT PERFORMANCE OF PAKISTAN'S ECONOMY

The agricultural sector in Pakistan experienced an average annual growth of 3.4 percent between 2000 and 2010 (Table 2.1). This growth rate is substantially lower than that experienced during 1990–2000, 4.4 percent per year. On a per capita basis, agricultural GDP grew at 1.3 percent per year, slightly less than the 1.7 percent observed for the previous decade. Except fishing, the real value-added of all components of agricultural GDP grew at slower rates compared to the rates observed during 1990–2000. The real value-added of forestry actually shrank in this period by 6.8 percent per year. Livestock, which accounts for 53 percent of agricultural GDP, registered slower growth in this period of 4.8 percent per year. Major crops (wheat, cotton, rice, and sugar cane) and minor crops, accounting for 32.8 and 11 percent of agricultural GDP respectively, grew the slowest in this period, 2.8 and 1.3 percent per year respectively. Services and Industry sectors grew almost twice as fast as agriculture during 2000–2010, growing at 5.8 percent and 6.4 percent per year respectively. Agriculture and industry have historically had comparable growth patterns and only started to diverge in the 2000s. The services sector started contributing larger shares of GDP starting in the 2000s (Figure 2.1).

Figure 2.1—Real GDP at factor cost in Pakistan, FY 1989 to FY 2010, in billions of FY1999 Pakistan Rupees



Source: Authors' calculations based on Pakistan Economic Survey 2010

Table 2.1—Agricultural GDP Growth in Pakistan, 1990 to 2010, at constant factor cost

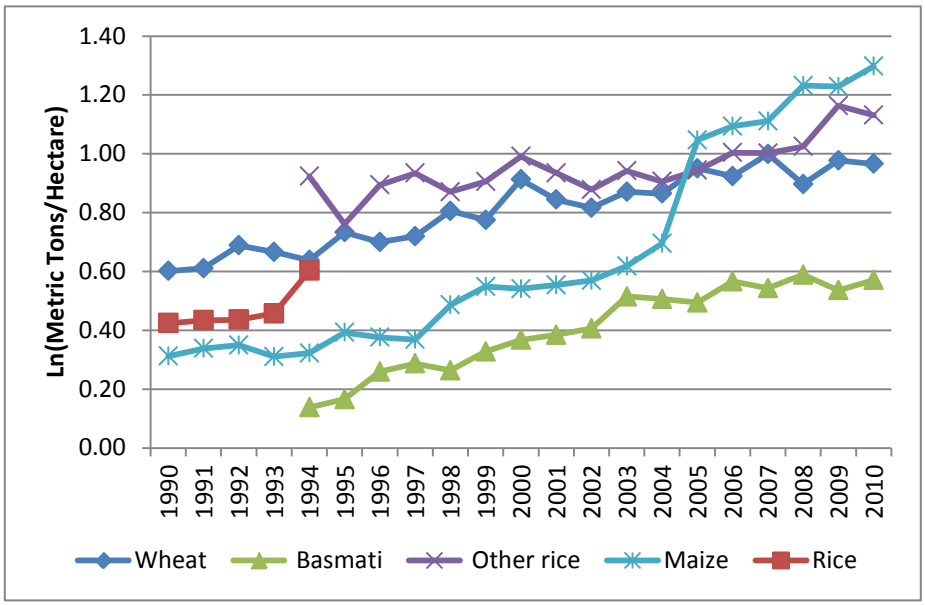
	2010 Value-added (Rs billion)	2010 Value-added (share of total GDP, percent)	2010 Value-added (share of Ag GDP, percent)	1990–2000 Growth Rate (percent)	2000–2005 Growth Rate (percent)	2005–2010 Growth Rate (percent)	2000–2010 Growth Rate (percent)
Agriculture	1,219	21.49	100.00	4.42	2.22	3.30	3.44
Major Crops	400	7.05	32.79	2.65	2.40	1.03	2.78
Minor Crops	135	2.38	11.08	4.84	0.26	1.96	1.32
Livestock	648	11.43	53.17	7.02	3.04	5.28	4.80
Fishing	22	0.38	1.77	2.72	-2.01	9.37	5.23
Forestry	14	0.25	1.18	-2.98	-3.35	-5.17	-6.80
Industry	1,428	25.18	117.16	3.92	7.61	3.17	6.37
Services	3,024	53.32	248.09	4.39	5.41	5.05	5.75
Total	5,671	100.00		4.28	5.17	4.18	5.36
Population (millions)	184.8			2.48	2.28	2.19	2.22
Agric GDP/capita (Rs/year)	6597.3			1.89	-0.05	1.09	1.19
Cropped Area (million ha)	19.4			0.92	0.30	1.12	0.87

Source: Authors' calculations based on Pakistan Economic Survey FY10, Table 1.3; Population data from IMF.
Note: Growth rates are calculated as logarithmic estimates of annual growth based on data from 1990 to 2010.

In 2010, the crop subsector accounted for 44 percent of the value-added of agriculture, and livestock for 53 percent of it. While total cultivated land continued to grow at a rate similar to that of the previous decade, the reduction of the growth rate of value-added in agriculture was partly related to the evolution of crop yields. Figure 2.2, which shows the yield of cereal crops in logs, suggests that the rate of growth of productivity in basmati rice and wheat decelerated in the last decade. The reduction in the rate of growth of agriculture was also related to a deceleration in the growth rate in the production of the livestock sector. While in 1990–2000 livestock grew (in real terms) at 7.0 percent per year, in the last decade the growth rate was below 5 percent. In the crop sector, average yields continued to grow in Pakistan although at rates which were generally lower than 1990–2000 rates. The fastest yield gains were in maize and basmati rice, 10.3 and 5.0 percent per year respectively (Table 2.2). Wheat showed a modest yield gain of 2.3 percent annually, while sugarcane and cotton yields grew by 1.5 and 1.9 percent per year respectively. Other food grains grew by 0.4 percent per year. Gram yield grew by 3.3 percent per year during this decade. The decadal growth rates conceal substantial year to year variation in yields (Figure 2.2). For instance, when the yield growth rates between 2008 and 2010 are considered, the rates are higher compared to the 1990–2000 rates.

Regarding international trade, Pakistan started the last decade with an economy that exported 12.2 percent of GDP and imported 15.3 percent of GDP (Table 2.3). Pakistan experienced considerable growth in exports and imports between 2000 and 2010. Export receipts grew by 11.8 percent per year during this period, while import payments rose by 17.2 percent per year. The faster growth in imports widened the trade deficit of the country, which changed from 2.2 billion in 2000 to 13.2 billion (current) USD in 2010. Remittances (transfers) and merchandise exports are the two largest sources of earnings in the current account balance of Pakistan, financing 30.7 percent and 56.3 percent of the net change in import payments respectively during this ten year period.

Figure 2.2—Cereal yields, 1990–2010, in logs



Source: Author's calculations based on Pakistan Economic Survey 2010 and Agricultural Statistics of Pakistan 2010.
Note: Separated data for basmati and other rice begins in 1994.

Table 2.2—Pakistan: Area, Yield, and Production of Selected Crops, 1990–2010

	Area 2010 ('000 Ha)	Area growth rate				Yield 2010 (MT /Ha)	Yield growth rate				Produc-tion 2010 ('000 MT)	Production growth rate			
		(FY90-FY00)	(FY00-FY10)	(FY00-FY05)	(FY05-FY10)		(FY90-FY00)	(FY00-FY10)	(FY00-FY05)	(FY05-FY10)		(FY90-FY00)	(FY00-FY10)	(FY00-FY05)	(FY05-FY10)
Wheat (major)	9,105	0.65	1.01	-0.15	1.82	2.63	2.51	1.24	0.87	0.39	23,917	3.18	2.26	0.72	2.21
Rice (major)	2,883	1.82	2.25	0.47	2.94	2.39	3.06	1.91	-0.35	3.66	6,883	4.94	4.20	0.12	6.71
Basmati*	1,544	2.03	2.83	5.20	-0.17	1.77	3.70	2.10	3.22	0.98	2,732	5.81	4.99	8.58	0.80
Other rice*	1,340	3.46	1.68	-5.25	7.51	3.10	1.69	2.09	-0.73	4.19	4,151	5.21	3.81	-5.94	12.02
Maize	950	1.24	0.88	0.30	-0.29	3.66	2.36	9.37	8.95	5.21	3,477	3.63	10.33	9.28	4.91
Other food grains	810	-1.55	-0.07	0.37	1.63	0.65	1.15	0.50	0.13	1.71	529	-0.42	0.43	0.50	3.37
Gram	1,050	0.16	1.68	2.51	-0.02	0.54	3.45	1.58	9.56	-3.79	571	3.61	3.28	12.31	-3.81
Sugar cane (major)	943	2.36	0.25	0.61	1.28	52.36	1.49	1.25	1.65	0.78	49,373	3.89	1.51	2.27	2.07
Cotton (major)	3,106	1.34	0.20	0.84	-1.23	0.71	-1.97	1.71	1.91	-1.29	2,197	-0.66	1.91	2.77	-2.50
Tobacco	50	1.82	0.16	-1.72	-0.34	2.10	1.33	1.27	0.52	1.51	105	3.18	1.43	-1.21	1.17
Other	551	1.67	-2.49	-1.13	-1.86	0.66	-3.92	0.46	0.47	0.04	365	-2.31	-2.04	-0.67	-1.82
Total	19,448	0.92	0.87	0.30	1.12										

Source: Authors' calculations based on Pakistan Economic Survey FY 2010, Table 2.1; Rice data from Agricultural Statistics of Pakistan FY 2010, Table 7.

Note: Growth rates are calculated as logarithmic estimates of annual growth based on data from 1990 to 2010.

* Basmati and other rice growth rates for 1990-2000 are based on data from 1994-2000

Table 2.3—Pakistan Current Account Balance of Payments FY2000–2010

	2000 (current billion USD)	As share of 2000 GDP	2010 (current billion USD)	As share of 2010 GDP	FY00–FY10 Net Change (current billion USD)	FY00–FY10 Annual Growth Rate (percent)	FY00–FY10 as share of Expendi-tures
Current Account Balance	-0.2	0.3	-3.9	2.2	-3.7	0.0	13.3
Incomes	13.7	18.6	38.1	21.6	24.4	11.7	86.7
Exports of goods and services	9.1	12.2	24.9	14.1	15.9	11.8	56.3
Exports of goods	8.2	11.1	19.7	11.1	11.5	10.5	40.8
Exports of services	0.9	1.2	5.2	3.0	4.4	20.3	15.5
Investment Income	0.6	0.9	0.6	0.3	-0.1	6.8	0.3
Current transfers	4.0	5.5	12.7	7.2	8.6	12.2	30.7
Expenditures	13.9	18.9	42.1	23.8	28.1	15.8	100.0
Imports of goods and services	11.3	15.3	38.1	21.6	26.8	17.2	95.4
Imports of goods	9.6	13.0	31.2	17.6	21.6	16.4	76.8
Imports of services	1.7	2.3	6.9	3.9	5.2	21.0	18.6
Investment Income	2.6	3.5	3.8	2.2	1.2	7.6	4.4
Current transfers	0.0	0.1	0.1	0.1	0.1	10.8	0.2

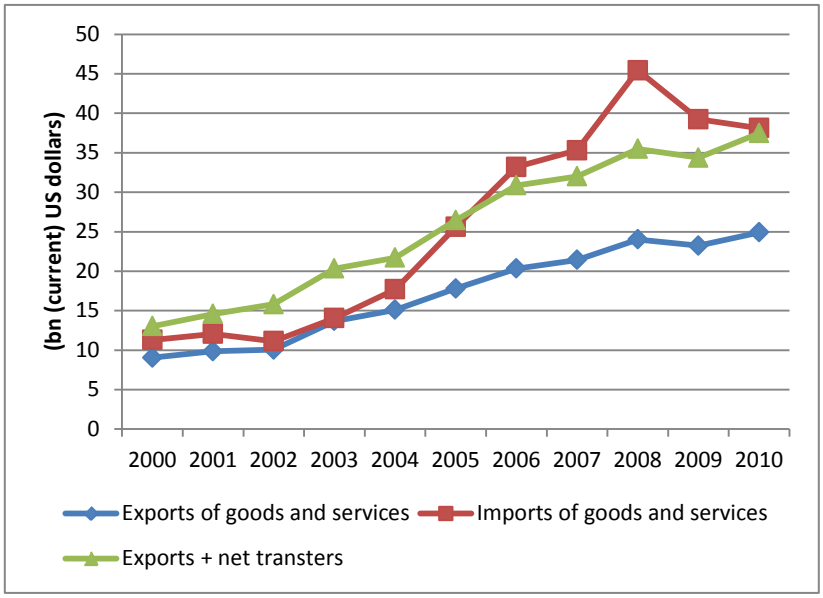
Source: Author's calculations based on Pakistan Economic Survey 2010, table 7.1.

Note: Growth rates are calculated as logarithmic estimates of annual growth based on data from 2000 to 2010.

Net investment income is negative (outflow) and was equal to $3.3 billion in FY 2010. For 2000, exports/imports of goods and services include 'merchandise', 'shipment', 'other transportation', and 'travel'.

While Pakistan had a trade deficit during the whole decade (Figure 2.3), between 2000 and 2005, receipts from exports of goods and non-factor services and remittances exceeded import payments for the same categories. This picture changed with large gaps emerging between the receipts and payments. The difference in import payments and receipts from exports and transfers peaked around 2008, and has since been shrinking, such that at present they are virtually aligned, with the current account deficit being fully explained by negative investment income.

Figure 2.3—Import payments and export receipts in Pakistan, 2000–2010



Source: Author's calculations based on Pakistan Economic Survey 2010, table 7.1.

Between 2000 and 2010, the federal budget continued to sustain large deficits. Federal revenues went up for all categories except earnings from excise duties and surcharges. During the 2000–2010 period, revenues grew by 5.09 percent per year on average. Direct tax earnings grew by 8.09 percent per year, while sales tax earnings grew by 5.73 percent per year. Non-tax revenue grew by 6.77 percent per year. In absolute terms, during this ten year period indirect tax earnings changed the most, Rs. 196.2 billion measured in constant (2005) rupees, followed by direct tax earnings and sales tax earnings (Table 2.4 and Figure 2.4).

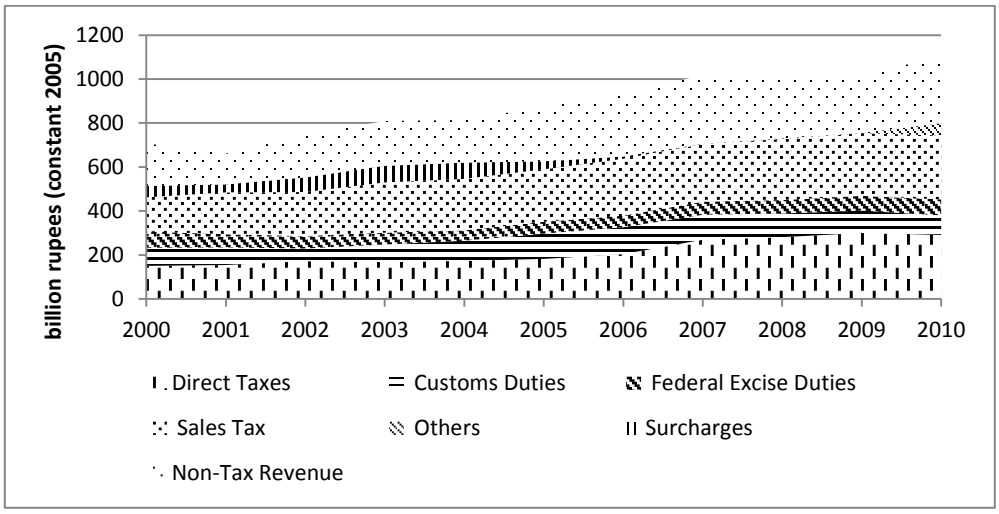
In absolute terms, however, federal expenditures grew much faster than revenues, increasing by Rs. 401.4 billion (2005) rupees between 2000 and 2010. Expenditure has been growing at 3.88 percent per year, a growth rate that is somewhat slower than the revenue growth rate of 5.09 percent (Figure 2.5 and Table 2.4). It should be noted that a large part of government revenues are transferred to provinces and contribute to the federal government's expenditures.

Table 2.4—Federal Government Revenues and Expenditures (2005 constant billion rupees)

	2000	2010	FY00–FY10 Annual Growth Rate (percent)	FY00–FY10 Net Change
Direct Taxes	150.4	291.2	8.09	140.8
Indirect Tax	311.8	507.9	4.96	196.2
Customs Duties	82.1	88.9	3.94	6.8
Federal Excise Duties	74.3	72.4	0.76	-1.9
Sales Tax	155.4	291.1	5.73	135.7
Others	0.0	55.5	167.41	55.5
Surcharges	51.8	0.0	-15.47	-51.8
Non-Tax Revenue	**193.4**	**306.5**	**6.77**	**113.1**
Subtotal	**707.4**	**1105.7**	**5.09**	**398.3**
Transfers to Provinces	**191.2**	**353.1**	**7.13**	**161.9**
Taxes on Income	51.2	118.6	10.03	67.4
Sales Tax	55.0	123.1	7.79	68.0
Excise Duty & Royalty on Natural Gas	10.1	17.2	6.58	7.1
Royalty on Crude Oil/Ex-gratia Grants	2.7	7.5	11.44	4.8
Surcharges	17.2	15.8	-1.86	-1.3
Custom Duties	29.6	37.1	5.60	7.6
Wealth Tax	0.0	0.0	0.00	0.0
Capital Value Tax	0.0	1.0	38.74	1.0
Federal Excise (Net of Gas)	25.4	29.5	3.05	4.1
G.S.T (Provincial)	0.0	3.2	4.58	3.2
Net Revenues (subtotal-transfers)	**516.2**	**752.6**	**4.22**	**236.3**
Expenditures				
Revenue: Current Expenditures	788.9	1087.0	3.84	298.0
Revenue: Development Expenditures	15.7	170.5	27.21	154.8
Capital Disbursements Current	79.4	62.2	-7.92	-17.2
Capital Disbursements Development	103.1	68.9	-1.76	-34.2
Total Expenditure	**987.2**	**1388.6**	**3.88**	**401.4**

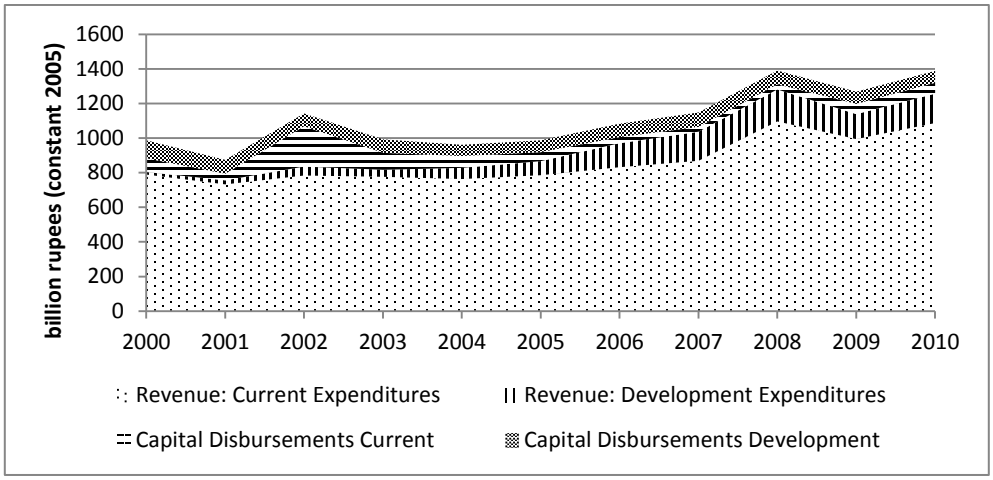
Source: Authors' calculations based on Pakistan Economic Survey 2010, Tables 3.1 and 3.2.
Note: GDP deflator used to convert nominal rupees to 2005 constant rupees. Growth rates are calculated as logarithmic estimates of annual growth based on data from 2000 to 2010.

Figure 2.4—Pakistan Federal Government Revenues, 2000–2010 (constant 2005 billion rupees)



Source: Authors' calculations based on Pakistan Economic Survey 2010, tables 3.1 and 3.2.
Note: GDP deflator used to convert nominal rupees to 2005 constant rupees.

Figure 2.5—Pakistan Federal Government Expenditures, 2000–2010 (constant 2005 billion rupees)



Source: Authors' calculations based on Pakistan Economic Survey 2010, tables 3.1 and 3.2.
Note: GDP deflator used to convert nominal rupees to 2005 constant rupees.

3. THE PAKISTAN COMPUTABLE GENERAL EQUILIBRIUM (CGE) MODEL AND THE 2007- 08 SAM

Following general equilibrium theory, representative consumers (households) and producers in our model are treated as individual economic agents. Households maximize a Stone-Geary Utility function, such that their consumer behavior is driven by a Linear Expenditure System (LES) taking income and commodity prices as given. Sector-specific producers have a constant elasticity of substitution (CES) value-added function with arguments given by labor, capital, and land, and choose factor inputs to maximize profits assuming wages and prices are given.

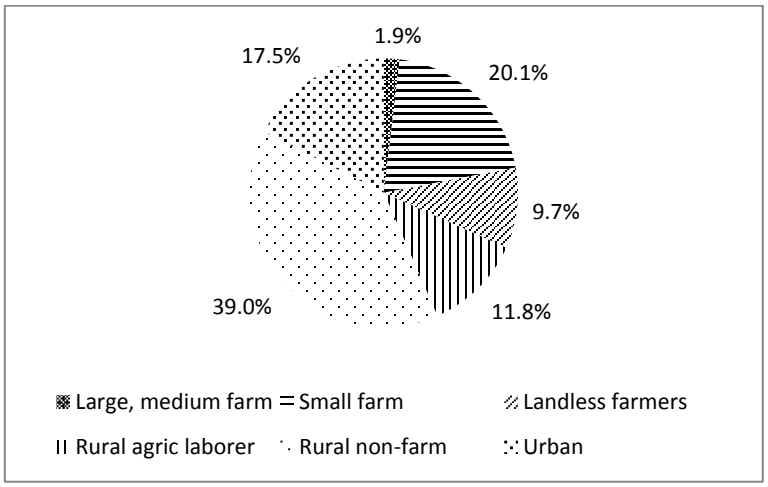
Import and export world prices are given (small country assumption). Domestically produced goods, imports, and exports are assumed to be imperfect substitutes. Imports are determined to minimize the cost of domestic absorption given import and domestic prices, and exports are determined to maximize producer profits given export and domestic prices. Commodity-specific domestic price changes equilibrate the commodity markets, and factor-specific wage changes equilibrate the factor markets. Households' incomes are the sum of factor and non-factor (transfers) income. Regarding macroeconomic closures, the model has: i) saving-driven investment, with exogenous marginal propensities to save for the households and endogenous investment; ii) fixed government fiscal balance as a share of domestic absorption; and iii) exogenous foreign savings and endogenous real exchange rate. The numeraire of the model is given by the consumer price index (CPI) basket.

The Pakistan CGE model includes 51 sector-specific producers, 27 production factors, and 18 representative household groups. Of the 51 production sectors, 12 are primary ones[1], and 8 of them produce crops. Regarding industrial production, there are 6 agricultural processing sectors for which output is closely linked to primary agricultural production. The remaining industrial sectors (14) include lint, yarn, clothing, knitwear, garments, other textiles, and other manufacturing. There are 19 service sectors. The primary factors of production in agriculture are agricultural labor (a composite of farmers' own labor and hired unskilled labor), agricultural capital, land, and water. In non-agriculture, the production factors are non-agricultural skilled labor, unskilled labor, and formal and informal capital. Farmers' own on-farm labor is used only in primary agriculture. Agricultural labor and land are mobile among agricultural activities. Non-agricultural skilled and unskilled labor is mobile among non-agricultural activities. Capital is fixed at the sector level, with separate sectoral rates of return. The 18 household groups in the model highlight differences in resources and location among the population, with emphasis on the rural area. The 12 agricultural-based groups are classified by household location (Punjab, Sindh, and Other Pakistan) and type of land holdings (large/medium farms, small farms, dry farms, and landless agricultural laborers). In addition, there are four non-farm national aggregates: rural non-farm poor and non-poor, and urban poor and non-poor. The urban poor are defined as those in urban expenditure quintiles 1 and 2. The rural non-farm poor are defined as those in rural expenditure quintiles 1 and 2.

The parameters of the model were calibrated in the light of the Social Accounting Matrix (SAM) for Pakistan 2007–2008, as described in Debowicz et al. (2012)[2]. The SAM uses data from various sources including the 2007–08 National Accounts, value-added and macroeconomic data available in the Handbook of Statistics of Pakistan, 1990–91 Input-Output Table (97 sectors), 2007–08 Agricultural Statistics of Pakistan, 2007–08 Pakistan Household Income and Expenditure Survey, commodity level trade data from the Ministry of Finance (MOF), and the 2000–2001 SAM for Pakistan (Dorosh, Niazi, and Nazli 2004). The elasticity of substitution among factors is in the 0.75–2.00 range, the supply of labor has a wage elasticity of 2, the income elasticities of consumption are in the 0.8–1.5 range, and trade elasticities are in the 0.5–5 range. The specific values of these parameters are presented in Appendix Tables B8–11.

The following figure, based on the 2007–08 Pakistan Household Income and Expenditure Survey, shows that more than 80 percent of the poor are in the rural area, a third of which (29.8 percent of the poor) are either small-holders or landless farmers.

Figure 3.1—Poverty in Pakistan, 2007–08



Source: HIES 2007–08.

The following table, based on the SAM for Pakistan and HIES 2007–08, shows that, out of a 130.6 million population represented by HIES, there are 53.8 million poor rural farmers. Being 41.2 percent of the total population, they only account

[1] The 12 primary sectors are: irrigated and non-irrigated wheat, IRRI and basmati rice, raw cotton, sugarcane, other major crops, fruits and vegetables (horticulture), cattle, poultry, forestry, and fisheries. The six agricultural processing industries are: wheat milling, IRRI and basmati rice milling, sugar, other food, and cotton lint and yarn. The 14 additional industrial sectors are: clothes, knitwear, garments, other textiles, leather, vegetable oil, wood products, chemicals, fertilizers, cement and bricks, mining, petroleum refining, other manufacturing, and mining. The 19 services are: wholesale trade, retail trade, restaurant and hotels, transport by rail, transport by road, transport by water, transport by air, other transport, housing, imputed rent, business services, health service, education service, personal services, financial services, other private services, and public-sector services.

[2] Debowicz, Dorosh, Haider, and Robinson. 2012. "A Social Accounting Matrix for Pakistan". PSSP Working Paper 01. Washington, DC: IFPRI. mimeo.

for 29.7 percent of the total income in the Social Accounting Matrix, or 19.0 percent in HIES. The table also suggests that HIES captures only a share of the total income in Pakistan, while the SAM, consistent with macro aggregates for the country, fully captures total income. The HIES underestimates population and incomes (since 1963–64 when the first HIES was conducted). That underestimation arises from the fact that the HIES does not sample cantonment areas, unsettled areas, or shifting populations such as nomadic and early migrants. The last two lead to an underestimation of the numbers in the lowest income/expenditure categories while the first leads to an underestimation of these in the highest income/expenditure categories.[3]

[3] Personal communication with Dr. Sohail Malik, IDS Pakistan.

Table 3.1—Population and per capita income in Pakistan, 2007–08

	SAM Income (Billion Rs)	Popula-tion (Millions)	SAM Income /Capita (Thou-sand Rs)	Share of Total Income (%)	Share of Total Popula-tion (%)	HIES Income (Billion Rs)	HIES Income /Capita (Thou-sand Rs)	HIES Expendi-ture (Billion Rs)	HIES Expendi-ture /Capita (Thou-sand Rs)	SAM Income /HIES Income Ratio
Large & Medium farm - Sindh	160.4	3.1	52.0	1.5	2.4	41.8	13.6	15.6	5.1	3.8
Large & Medium farm - Punjab	652.6	3.5	185.5	6.2	2.7	191.3	54.4	88.4	25.1	3.4
Large & Medium farm - Other	89.6	0.5	187.5	0.8	0.4	16.8	35.2	10.7	22.5	5.3
Small farm - Sindh	192.2	0.7	272.1	1.8	0.5	61.4	86.9	54.0	76.5	3.1
Small farm - Punjab	1223.0	2.2	567.7	11.5	1.6	417.4	193.8	406.6	188.7	2.9
Small farm - Other	348.8	0.5	683.2	3.3	0.4	101.7	199.2	118.0	231.1	3.4
Landless Farmer - Sindh	144.7	2.5	57.3	1.4	1.9	45.2	17.9	42.5	16.8	3.2
Landless Farmer - Punjab	193.3	3.6	54.4	1.8	2.7	81.7	23.0	71.2	20.0	2.4
Landless Farmer - Other	79.9	1.7	46.3	0.8	1.3	25.0	14.5	28.4	16.5	3.2
Landless Agricultural Laborers - Sindh	155.5	3.1	49.4	1.5	2.4	36.3	11.5	56.4	17.9	4.3
Landless Agricultural Laborers - Punjab	148.0	16.0	9.3	1.4	12.2	32.9	2.1	59.9	3.7	4.5
Landless Agricultural Laborers - Other	19.1	5.6	3.4	0.2	4.3	5.6	1.0	7.9	1.4	3.4
Rural non-farm quintile 1	295.9	9.0	33.1	2.8	6.9	105.4	11.8	62.1	6.9	2.8
Rural non-farm quintile 2	351.6	8.9	39.3	3.3	6.8	112.0	12.5	91.1	10.2	3.1
Rural non-farm other	1831.9	26.8	68.2	17.3	20.6	575.9	21.5	529.6	19.7	3.2
Urban quintile 1	277.8	8.6	32.4	2.6	6.6	289.4	33.7	82.2	9.6	1.0
Urban quintile 2	356.3	8.6	41.6	3.4	6.6	138.6	16.2	115.7	13.5	2.6
Urban other	4084.9	25.7	158.7	38.5	19.7	726.8	28.2	793.2	30.8	5.6
Rural farm sub-total	3407.0	43.0	79.2	32.1	32.9	1057.2	24.6	959.7	22.3	3.2
Rural non-farm sub-total	2479.3	44.7	55.4	23.4	34.2	793.2	17.7	682.8	15.3	3.1
Urban subtotal	4719.0	42.9	110.1	44.5	32.8	1154.8	26.9	991.1	23.1	4.1
Total households	10605.3	130.6	81.2	100.0	100.0	3005.3	23.0	2633.5	20.2	3.5
Rural poor household groups	3151.9	53.8	58.6	29.7	41.2	1024.6	19.0	998.0	18.5	3.1

Source: SAM for Pakistan 2007–08 and HIES 2007–08

4. MODEL SIMULATIONS

In this chapter, we examine the effects of increased sectoral productivity on output and income distribution. First, in order to understand the contribution of various sub-sectors, we examine the effects of identical 10 percent increases in total factor productivity for various sectors of the economy (Simulations 1 through 4) and for all sectors of the economy (Simulation 5). Then, in the last part of the chapter, we simulate a continuation of historical productivity growth for each sector of the economy (Simulation 6), accelerated productivity growth in industry and services, broadly consistent with the thrust of the Framework for Economic Growth (Simulation 7), and accelerated productivity growth in agriculture, as well as accelerated productivity growth in industry and services (Simulation 8). Comparing Simulations 7 and 8, we are then able to estimate the marginal impact of adding accelerated agricultural productivity growth to the Framework for Economic Growth. In order to assess the distributional effects of the accelerations in productivity, we consider the implications for the welfare of various household groups, considering their initial composition of income and the implied changes in the wages of the production factors from which they derive their income.

4.1. Implications of Sectoral Productivity Growth

Simulations 1 through 4 model the effects of a 10 percent increase in total factor productivity growth in crops and agricultural processing (milling of rice and wheat, sugar refinement, other food, lint and yarn), (Simulation 1); cattle and poultry (Simulation 2); industry (excluding the agricultural processing sectors), (Simulation 3); services (Simulation 4); and all sectors simultaneously (Simulation 5).

In these five scenarios, increased total factor productivity results in increased output of a sector, but a reduction in the amount of labor, land, and capital used in that sector. The increase in supply of the sector's goods (or services) results in a decline in the real price since demand increases (brought about by increases in household incomes and investment demand) are in general less than the increase in supply. At the same time, the reduction in use of factor of production from the sector experiencing the productivity shock frees up these factors for use in other sectors of the economy. Thus, real GDP (value-added at base year prices) rises in all scenarios as does total household income. The size of the change in real GDP, the changes in output quantities and prices, and changes in incomes of various household groups all vary according to which sector is shocked.

4.2. GDP Growth

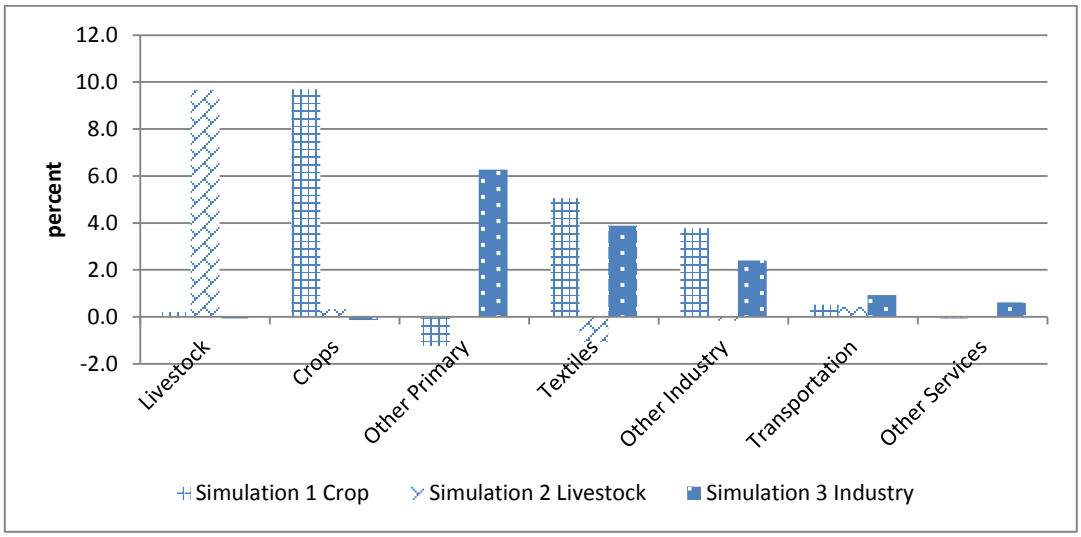
The enhanced productivity in crops, livestock, industry and services lead, respectively, to gains in annual GDP of 1.8, 1.0, 1.2, and 5.4 percent. In general, the effect on total GDP largely reflects the size of the sector that is shocked. When total factor productivity is increased for all the sectors in the economy at the same time, the gain in GDP is 10 percent. Productivity shocks increase production not only in the sector that experiences the shock, but they also lead to increased production in other sectors, as factors of production (particularly labor) are able to move to other sectors. For example, increasing the productivity in crops leads to an overall increase in GDP of 1.8 percent, with value-added in the primary sector increasing by 4.4 percent, the industrial sector (which is strongly linked to the primary one) by 3.8 percent and the services sector by 0.1 percent (Table 4.1). (See Appendix Table B.2 for simulation results by production activity.) Livestock/dairy accounts for 11 percent of domestic GDP. Over 6 million small farmers and landless rural workers are engaged in dairy production, with women often responsible for, and managers of, the resulting incomes. As a consequence, improvements in productivity of small-scale dairy production would have very widespread benefits throughout rural areas. In the livestock/dairy growth scenario, annual GDP of the primary sector increases by 5.2 percent.

Table 4.1—Value-added in real terms (Base in billion rupees, rest in % changes)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
TOTAL	9921.6	1.8	1.0	1.2	5.4	10.0
Primary	2017.2	4.4	5.2	0.0	0.0	10.0
Industry	2252.0	3.8	-0.2	3.3	2.5	10.2
Service	5652.4	0.1	0.1	0.8	8.5	9.9

Source: Model simulations.

Figure 4.1—Effects of productivity shocks on real value-added



Source: Model simulations.

4.3. Relative prices and international trade

For each of the first four simulations, the increases in output have significant negative effects on market prices. For example, if only the productivity of crops is increased (Simulation 1), the relative prices of crops fall by between 6 and 11 percent. If only the productivity of livestock is increased, then the prices of livestock products decrease by 12 to 13 percent (Table 4.2 and, with further disaggregation, Appendix Table B.3). The same holds for industry and for services. This outcome arises because supply of these products rises faster than demand. When productivity increases for all sectors of the economy (Simulation 5), however, the gain in incomes is large enough to prevent a decline in relative output prices (Table 4.2). In this case, the increase in incomes leads to an increased demand for foreign goods (imports) that is greater in value than the increase in supply of foreign goods (exports). With foreign savings fixed, the real exchange rate depreciates by 2.3 percent to bring supply and demand for foreign exchange into balance.[4]

Table 4.2—Output prices (% changes)

	BASE	Simulation 1 Crop	Simulation 2 Live-stock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Livestock	1.0	-0.6	-12.8	-1.4	14.5	0.2
Crops	1.0	-8.9	2.4	-0.3	7.7	0.5
Other Primary	1.0	0.7	0.6	-4.3	6.4	1.1
Textiles	1.0	-0.2	1.3	0.0	0.0	1.7
Other Industry	1.0	-0.5	-0.1	-4.6	6.9	0.2
Transportation	1.0	4.6	2.8	0.7	-6.7	0.7
Other Services	1.0	5.8	3.1	4.4	-13.8	0.5
Real exchange rate	1.0	0.4	1.1	-0.7	1.0	2.3

Source: Model simulations.

Increasing the productivity of crops by 10 percent leads the economy to increase its crops exports by 45 percent (Table 4.3), where the export of lint increases by 51 percent, yarn by 25 percent, and vegetables and fruits by 45 percent (Appendix Table B.4), while it leads to crop imports contracting by 17 percent (Table 4.4), with import of wheat falling by 18 percent, of other crops by 14 percent, and of vegetables and fruits by 11 percent (Appendix Table B.5). In turn, the higher net export in these sectors allows the economy to finance an increase in its imports both of industrial goods and services, as shown in Table 4.4 and Appendix Table B.5. For example, the economy increases its imports of cloth by 8 percent and of other textiles by 10 percent.

[4] Note that the consumer price index is fixed as the numeraire of the model. As the nominal (and real) exchange rate depreciates, prices of importable and exportable goods rise and prices of non-tradables such as retail trade and cement fall, leaving the total consumer price index unchanged.

Table 4.3—Exports in real terms (Base in billion rupees, rest in % change)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Livestock	2.6	2.3	47.1	1.4	-22.0	14.6
Crops	11.5	45.2	-4.2	-3.7	-12.7	14.3
Other Primary	10.4	-3.3	5.2	1.2	-22.3	17.3
Textiles	563.0	5.8	-1.4	3.9	5.8	13.5
Other Industry	446.9	13.0	8.2	12.4	-15.3	17.4
Transportation	223.3	-5.5	-1.7	0.3	17.7	12.6
Other Services	244.2	-3.4	0.4	-3.1	22.1	13.4

Source: Model simulations.

Table 4.4—Imports in real terms (Base in billion rupees, rest in % change)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Livestock	3.8	5.9	-15.3	4.0	9.6	3.3
Crops	79.6	-17.1	5.8	1.3	18.2	4.8
Other Primary	284.7	2.5	-0.3	-6.4	10.4	7.1
Textiles	89.9	-0.3	2.2	6.9	-0.9	7.7
Other Industry	1250.9	2.1	0.5	1.3	4.4	8.4
Other Services	467.9	7.2	2.1	9.4	-10.8	6.2

Source: Model simulations.

In the joint simulations, and as shown in Table 4.5, real wages and rents of the production factors (labor, land, and capital) increase by around 10 percent. When only the productivity of crops increases, the relative remuneration to land drops significantly (around 6–10 percent), a result mostly associated with the previously described fall in the relative price of agriculture. Similarly, increasing the productivity of livestock leads to a fall in the remuneration of livestock capital (9.0 percent) (Appendix Table B.6). Besides, when the relative price of livestock falls, part of the labor force moves out of livestock into the production of crops, increasing the productivity of the stock of land in this production, and hence its remuneration.

The strong link between relative prices and wages of factors employed in the sectors suggests that interventions targeted to specific sectors are prone to generate significant income redistributions at the factor level.

Table 4.5—Real wages (Index for non-capital base, 20% rental rate for capital in the base, rest in % change)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Agricultural Labor	319.8	-6.0	0.0	0.3	14.0	10.6
Non-Ag Labor	2088.5	1.0	0.2	-1.4	9.0	10.9
Ag Capital + Land	673.3	-8.6	2.5	1.8	14.5	10.4
Non Ag Capital + Transfers	6076.8	4.8	2.5	0.8	0.7	9.5
Livestock	763.3	0.7	-9.0	-1.9	17.8	10.1

Source: Model simulations.

4.4. Per-Capita Household Incomes

The described changes in relative wages lead to changes in the household per capita incomes (Table 4.6 and Figure 4.2). Per-capita income is the key determinant of household economic status and levels of poverty. Improved agricultural productivity has positive effects on rural per-capita income and creates very significant and positive income linkages that benefit the rural non-farm (poor and non-poor) and the urban (poor and non-poor), as they allow them to buy agricultural output at a lower real cost. Actually, improving agricultural productivity is, among the individual scenarios analyzed, the one that leads to the highest increases in rural non-farm and urban household incomes.

The only exception to the increase in income in the agricultural productivity simulation is given by the large/medium land holders, whose income relies heavily on land and, as the remuneration of land falls as described above and noted in the following table, their incomes shrink[5].

Table 4.6—Household per capita income (Base in thousand rupees per year, rest in % change)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Medium-large farms	241.7	-2.4	1.6	2.2	6.7	9.6
Small-dry farms	67.0	1.7	0.3	2.0	2.8	8.8
Agricultural wage laborers	48.0	4.3	1.6	3.0	-2.4	8.9
Non-farm poor	38.0	3.9	1.5	2.3	-0.7	9.3
Non-farm non-poor	66.2	3.8	1.7	1.6	-0.3	8.9
Urban poor	37.0	2.6	1.4	1.0	2.2	9.3
Urban non-poor	158.8	2.2	0.8	-2.3	8.3	9.0
Total	81.2	2.2	1.0	0.3	4.3	9.0

Source: Model simulations.

To understand the factors driving the simulated changes in household income, it is useful to decompose household incomes by source: factor income (labor, capital, and land) and transfers:

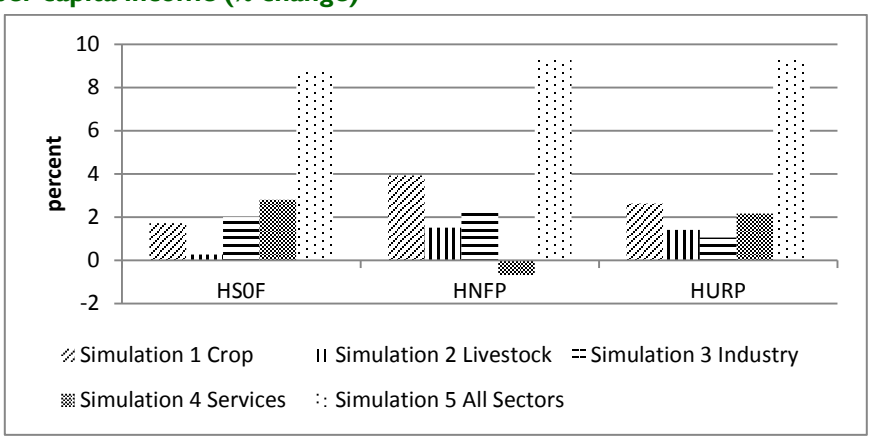
$$Y_h = \sum_f \theta_{hf} YF_f + \sum_{i=G,R} \theta_{hi} TR_{hi}$$

where Y_h stands for the income of each of the household groups, YF_f for the income of each of the factor groups (land, capital, and labor), TR_{hi} for the transfers received by the households from the public sector and the non-residents (all in local currency), and θ_{hf} and θ_{hi} for the share that each income source (factors, government, and non-residents) pay to household *h*.

Differentiating this equation taking into account that θ_{hf} and θ_{hi} are constant in the model gives:

$$\Delta Y_h = \sum_f \theta_{hf} \Delta YF_f + \sum_{i=G,R} \theta_{hi} \Delta TR_{hi}$$

Figure 4.2—Household per capita income (% change)



Source: Model simulations.

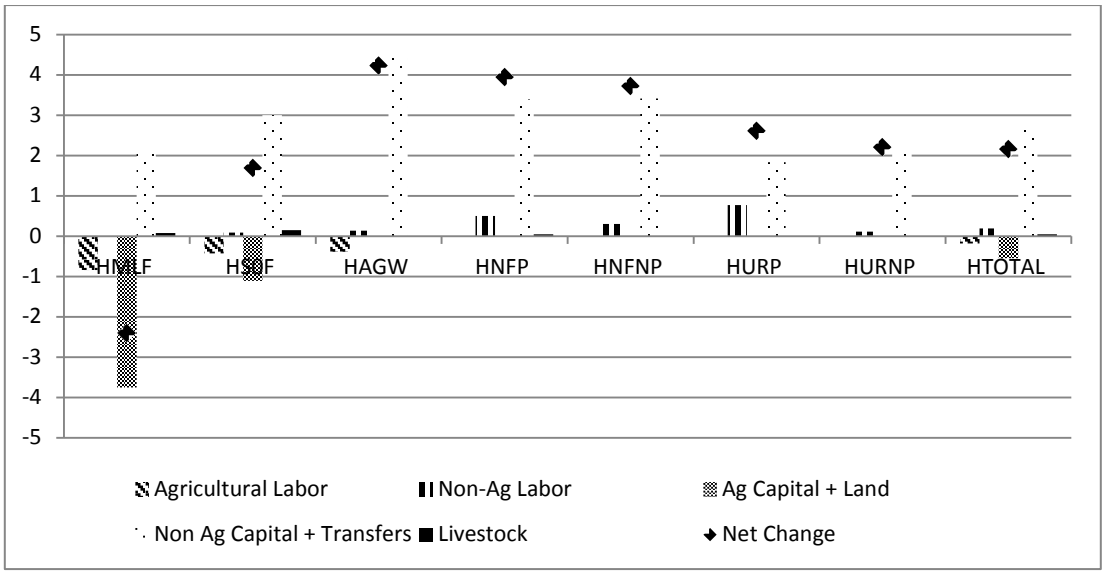
[5] Further analysis is called for to fully assess the distribution of income gains resulting from improved agricultural productivity. Increased growth in productivity for major crops results in greater gains for urban per-capita household income growth than for rural, while the impacts are closer for increased productivity growth for horticulture or livestock/dairy. The result for major crops may reflect too large a decline in domestic crop prices (and thus returns to farm labor and land) as production increases relative to demand for crops. Note that improved productivity growth in the non-agricultural sectors counteracts this effect. The non-agricultural productivity growth raises rural per-capita household incomes because increases in non-agricultural national income lead to greater demand for agricultural products. The model simulations assume world crop prices (and prices of other traded goods) remain constant. To the extent that Pakistan improves its trade regime and capacity so that domestic crop and livestock prices are more closely linked to world prices, there will be less downward pressure on domestic prices from expanded agricultural production and, in general, less sensitivity to solely domestic factors.

And, dividing by household income on both sides,

$$\Delta Y_h / Y_h = \sum_f \frac{\theta_{hf} \Delta YF_f}{Y_h} + \sum_{i=G,R} \theta_{hi} \Delta TR_{hi} / Y_h.$$

Applying this equation to the Simulation 1 (10 percent increase in TFP of the crop sector), where the productivity in the crops increases, we can decompose the changes in the household incomes generated by this simulation. As shown in Figure 4.3, the main driver of household income in this scenario is the change in the wage of informal capital (which increases by 8 percent, as shown in Appendix Table B.6). For example, the income of small farms increases when agricultural productivity increases by 1.7 percent., which can be decomposed into a 3.0 percent increase due to the increase in the wage of informal capital, a 1.0 percent decline due to the fall in land income, and other factors (-0.3 percent) (Figure 4.3). For the households heavily relying on land income (i.e. the large and medium farms), the positive effect of the increase in the wage of informal capital (2.1 percent) is more than offset by the negative effect of the fall in the wage of land (3.3 percent) which, together with a fall in the wage of agricultural labor (0.8 percent), agricultural capital (0.5 percent), and other factors, lead to a fall in household income of 2.4 percent. The numerical results for each simulation are provided to the interested reader in Appendix Table B.7.

Figure 4.3—Decomposition of the changes in household income (% change) with 10% increase in productivity of crops



Source: Model simulations.

The first three simulations (agricultural, livestock, and industrial productivity growth), through their increase in production, lead to significant increases in transaction costs that rely heavily on retail trade, which in turn is an intensive user of informal capital. As output goes up, the demand for retail trade and hence for informal capital increases, generating an increase in the wage of informal capital that drives the bulk of the changes in household income. The industrial productivity simulation also lifts the demand for urban formal capital, lifting its wage and the income of the urban non-poor.

In Simulation 4 (services productivity increases), the relative prices of services fall, lowering the demand for informal capital and leading to a fall in its wage and decline in household income by 1.4 to 6.4 percent, depending on the composition of household incomes. The increase in the service sector also leads to higher demand for agricultural and industrial commodities, so most of the households end up with income increases, but in the case of agricultural wage laborers, non-farm poor, and non-farm non-poor, the decline in income due to the fall in the wage of informal capital more than offsets other effects, leading their incomes to fall by 2.4, 0.7, and 0.3 percent, respectively (Appendix Table B.7).

4.5. Implications of the Productivity Growth in the Framework for Economic Growth

In this section, we extend the analysis by using actual historical growth rates by sector, instead of a constant 10 percent productivity growth rate across sector (Simulation 6). We then simulate the major thrust of the Framework for Economic Growth, accelerating productivity growth in industry and services such that the productivity growth rate in each activity is

double its recent historical growth rate (Simulation 7). Finally, in Simulation 8, we simulate the effects of adding accelerated productivity growth in agriculture to the accelerated productivity growth in industry and services of the previous simulation.

Table 4.7 shows the exogenous productivity changes that we apply in each of the simulations to the sectors in the Pakistan economy, except for the last column, which shows the ratio between the percent change in productivity in Simulations 7 and 8 by sector of production.

The production in the economy, measured by value-added in real terms, increases over the five year period by a total of 6.2 percent, with industry growing slightly more than the other sectors (6.8 percent vs. 6.0 percent). With investments targeted to non-agricultural sectors, the economy grows 10.6 percent, with industrial and services production growing significantly more (10.9 and 12.1 percent respectively), and some spillover on the primary sector (which grows 6.3 percent instead of 6.0 percent). Finally, with economy-wide investments, each of the sectors (primary, industry, and services) grows by an average yearly growth of 2.3 percent and more than 12 percent for the five-year period under consideration (Table 4.8).

Table 4.7—Effects of Historical Productivity Shocks on Output by Sector

Activity	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agric Productivity Gain
Irrigated wheat	7.7	7.7	15.9	2.1
Non-irrigated wheat	7.7	7.7	15.9	2.1
Rice IRRI	6.7	6.7	13.7	2.1
Rice basmati	6.7	6.7	13.7	2.1
Cotton (irr)	7.7	7.7	15.9	2.1
Sugar cane (irr)	4.1	4.1	8.3	2.0
Other field crops	7.7	7.7	15.9	2.1
Fruits/vegetables	7.7	7.7	15.9	2.1
Livestock (cattle, milk)	5.1	5.1	10.4	2.0
Livestock (poultry)	5.1	5.1	10.4	2.0
Forestry	7.7	15.9	15.9	1.0
Fishing	5.1	10.4	10.4	1.0
Mining	7.7	15.9	15.9	1.0
Veg Oils	4.1	8.3	8.3	1.0
Wheat Milling	7.7	7.7	15.9	2.1
Rice Milling (IRRI)	7.7	7.7	15.9	2.1
Rice Milling (basmati)	7.7	7.7	15.9	2.1
Sugar	4.7	4.7	9.5	2.0
Other food	7.7	7.7	15.9	2.1
Cotton gin (lint)	7.7	7.7	15.9	2.1
Cotton spinning (yarn)	7.7	7.7	15.9	2.1
Cotton weaving (cloth)	7.7	15.9	15.9	1.0
Knitwear	7.7	15.9	15.9	1.0
Garments	7.7	15.9	15.9	1.0
Other Textiles	7.7	15.9	15.9	1.0
Leather	7.7	15.9	15.9	1.0
Wood	7.7	15.9	15.9	1.0
Chemicals	7.7	15.9	15.9	1.0
Fertilizer	7.7	15.9	15.9	1.0
Cement, bricks	2.5	5.1	5.1	1.0

Table 4.7—Continued.

Activity	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agric Productivity Gain
Petroleum refining	5.1	10.4	10.4	1.0
Other Manufacturing	5.1	10.4	10.4	1.0
Energy	5.1	10.4	10.4	1.0
Construction	6.1	12.6	12.6	1.0
Trade-wholesale	6.1	12.6	12.6	1.0
Trade-retail	6.1	12.6	12.6	1.0
Trade-other (rest, hotel)	6.1	12.6	12.6	1.0
Transport-Rail	6.1	12.6	12.6	1.0
Transport-Road	6.1	12.6	12.6	1.0
Transport-Water	6.1	12.6	12.6	1.0
Transport-Air	6.1	12.6	12.6	1.0
Transport-Other (pipes)	6.1	12.6	12.6	1.0
Housing	6.1	12.6	12.6	1.0
Imputed Rent	6.1	12.6	12.6	1.0
Business Services	6.1	12.6	12.6	1.0
Health care	6.1	12.6	12.6	1.0
Education	6.1	12.6	12.6	1.0
Personal Services	6.1	12.6	12.6	1.0
Other Priv Services	6.1	12.6	12.6	1.0
Public Services	5.1	10.4	10.4	1.0
Finance and Insurance	6.1	12.6	12.6	1.0

Source: IPCGE Model.

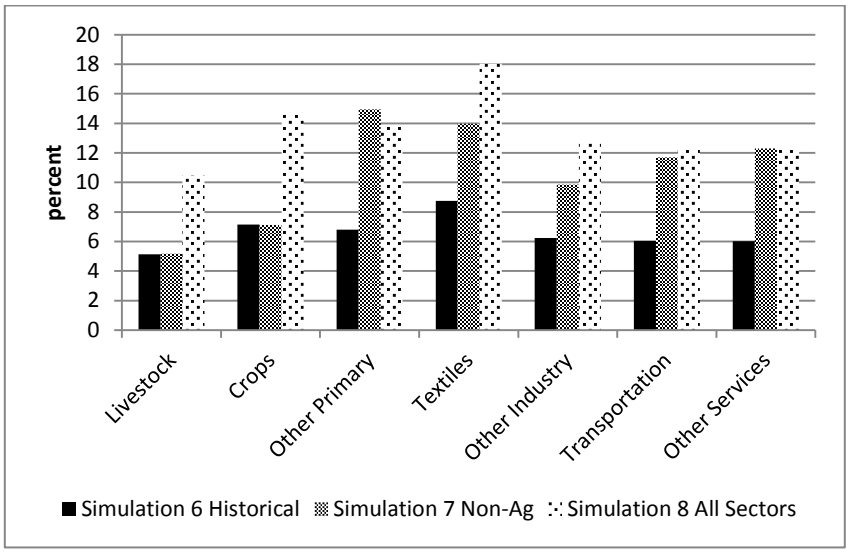
Table 4.8—Value-added in real terms (Base in billion rupees, rest in % changes)

	BASE	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agric Productivity Gain)
TOTAL	9922	6.2	10.6	12.6	2.0
Primary	2017	6.0	6.3	12.4	6.1
Industry	2252	6.8	10.9	13.9	3.0
Service	5652	6.0	12.1	12.2	0.2

Source: Model simulations.

The following figure disaggregates the economy into seven sectors. Overall, it suggests that each of these sectors grows more with economy-wide investments[6] than with investments focused on non-agriculture, a point particularly prominent for textiles, which grows 4 additional percentage points.

Figure 4.4—Value-added in real terms by sector



Source: Model simulations.

[6] The only exception is "other primary" (forestry, fishing, and mining), which accounts for only 3.8 percent of GDP.

While the historical and country-wide investments simulations (Simulation 6 and Simulation 8) are relatively balanced, and hence generate changes in relative prices that do not exceed 4 percentage points at the 7-sector disaggregation, investments that are focused towards the non-agriculture sectors lead production in those sectors to increase significantly more than in agriculture, and hence generate relative scarcity of agricultural goods, in turn generating a significant increase in the relative price of primary goods relative to other goods. With the CPI fixed, the non-agricultural investments lead to an increase in the price of livestock by 10.6 percent, and crops by 3.8 percent, while the prices of transportation and other services decrease by 3.5 percent and 5.1 percent, respectively (Table 4.9).

Table 4.9—Output prices (% changes)

	BASE	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agric Productivity Gain
Livestock	1.0	1.8	10.6	3.5	-7.1
Crops	1.0	-0.5	3.8	-1.0	-4.8
Other Primary	1.0	-0.1	-1.3	-0.2	1.1
Textiles	1.0	0.6	0.6	1.1	0.5
Other Industry	1.0	0.6	1.8	1.3	-0.5
Transportation	1.0	0.6	-3.5	1.1	4.6
Other Services	1.0	0.4	-5.1	0.6	5.7
Real exchange rate	1.0	1.2	1.3	2.2	0.9

Source: Model simulations.

In the historical simulation, as the economy grows, exports grow in each of the exporting sectors, from 3.8 percent (livestock) to 12.0 percent (crops). But with non-agricultural investments, industry and services become the most dynamic sectors in terms of export growth. With countrywide investments, exports grow in each sector, from 7.1 percent (other primary) to 25.2 percent (crops) (Table 4.10).

Table 4.10—Exports in real terms (Base in billion rupees, rest in % change)

	BASE	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agric Productivity Gain
Livestock	2.6	3.8	-11.8	7.5	19.4
Crops	11.5	12.0	0.4	25.2	24.8
Other Primary	10.4	3.6	8.0	7.1	-0.9
Textiles	563.0	10.3	16.7	21.2	4.4
Other Industry	446.9	9.8	6.4	20.1	13.7
Transportation	223.3	7.1	19.6	14.4	-5.2
Other Services	244.2	7.6	18.2	15.5	-2.7

Source: Model simulations.

With the economy having access to a constant level of foreign savings in real terms, the overall increases in exports just described allow the economy to increase its imports. The results suggest that if the economy also invests in the agricultural sector, then it will need much lower imports of livestock and crops (4.7 p.p. and 10.1 p.p., respectively) (Table 4.11).

Table 4.11—Imports in real terms (Base in billion rupees, rest in % change)

	BASE	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agric Productivity Gain
Livestock	3.8	5.6	16.2	11.5	-4.7
Crops	79.6	1.2	12.6	2.5	-10.1
Other Primary	284.7	3.1	4.5	6.5	2.0
Textiles	89.9	5.2	9.5	10.7	1.2
Other Industry	1250.9	5.4	9.2	11.2	2.0
Other Services	467.9	4.3	2.9	8.7	5.8

Source: Model simulations.

The productivity increases in the historical simulation allow wages to increase from 6.2 percent (non-agricultural capital) to 7.6 percent (livestock). With non-agricultural investments, the wage of each of the factors grows, but the wages of the factors linked to agriculture (where the relative prices increase) increase by more. Finally, with country-wide investments, as

the relative prices do not move significantly, the wages of the production factors increase more homogeneously, in the range of 12.8–15.5 percent (Table 4.12).

Table 4.12—Real wages (Index for non-capital base, 20% rental rate for capital in the base, rest in % change)

	BASE	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agric Productivity Gain
Agricultural Labor	319.8	6.6	16.3	13.5	-2.9
Non-Ag Labor	2088.5	6.8	13.0	14.0	1.0
Ag Capital + Land	673.3	6.3	15.8	12.8	-3.0
Non Ag Capital + Trans-fers	6076.8	6.2	7.6	12.8	5.1
Livestock	763.3	7.6	19.0	15.5	-3.5

Source: Model simulations.

Household incomes are primarily composed of factor income, such that the changes in the wages described above shape the changes in household incomes. In the non-agricultural investments simulation household per capita incomes increase by 9.3 percent on average, with the medium and large farms and the urban non-poor enjoying much higher increases than the poor (11.7 percent for medium-large farms and 10.3 percent for urban non-poor compared to 6.7 percent for agricultural wage laborers, 7.6 percent for non-farm poor, and 8.6 percent for urban poor). Country-wide investments lead to household income increases that are much more homogenous, in the 11.2–12.6 percent range for each of the household groups (Table 4.13).

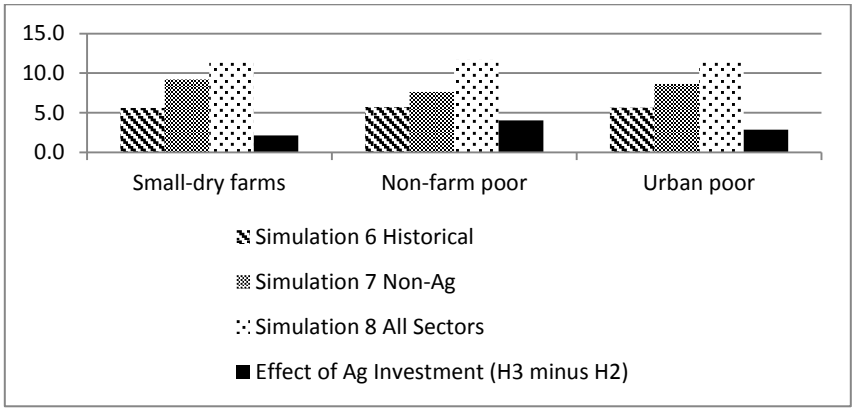
Table 4.13—Household per capita income (Base in thousand rupees per year, rest in % change)

	BASE	Simulation 6 Historical	Simulation 7 Non-Agriculture	Simulation 8 All Sectors	Effect of Agriculture Productivity Gain
Medium-large farms	241.7	5.9	11.7	12.1	0.4
Small-dry farms	67	5.6	9.2	11.4	2.2
Agricultural wage laborers	48	5.5	6.7	11.2	4.5
Non-farm poor	38	5.7	7.6	11.7	4
Non-farm non-poor	66.2	5.6	7.3	11.3	4
Urban poor	37	5.6	8.6	11.5	2.9
Urban non-poor	158.8	6.1	10.3	12.6	2.2
Total	81.2	5.8	9.3	11.9	2.6

Source: Model simulations.

Finally, the results in the following figure show that per capita incomes of the poor increase with non-agricultural investments, but increase even more with country-wide investments, with the agricultural investments allowing for additional income increases for the small-dry farms (2.2 percent), non-farm poor (4.0 percent), and urban poor (2.9 percent).

Figure 4.5—Household per capita income (% change)



Source: Model simulations.

6. CONCLUDING OBSERVATIONS

Over the past two decades, Pakistan has achieved steady, though not rapid, economic growth, with real GDP growth averaging 4.3 percent in the 1990s and 5.4 percent in the 2000s. Under the new Framework for Economic Growth, productivity and economic growth are expected to increase further through additional **development of markets and increased efficiency of government**. The Framework also places substantial emphasis on vibrant cities as engines of growth, with relatively less emphasis on the rural economy. This implicit distribution of growth in productivity and output across sectors, however, has significant implications for distribution of the economic gains.

Increased productivity in the non-agricultural sector has been a potent source of growth in the past decade and further gains in productivity would have positive effects on growth and household incomes. Computable General Equilibrium (CGE) model simulations using a new 2008 Social Accounting Matrix (SAM) for Pakistan show that achieving high productivity growth targets broadly consistent with the Framework for Economic Growth would imply a 9.3 percent per year gains in average household income (compared to trend growth in household incomes of 5.8 percent). Average incomes of the urban non-poor would rise by 10.3 percent, compared with 6.1 percent in the historical growth rate scenario. Farmers' average incomes would also rise sharply (11.7 percent for medium-large farmers as compared to 5.9 percent in the historical growth rate scenario). These household gains result in large part because of substantial increases in the real prices of livestock and crops (10.6 and 3.8 percent, as compared to 1.8 percent and -0.5 percent in in the historical growth rate scenario). However, major poor household groups, particularly agricultural wage laborers and the rural non-farm poor, would see only relatively small gains in average real incomes, by an additional 1.2 to 1.9 percentage points relative to the historical growth rate scenario.

Accelerating agricultural growth as well would result in even greater overall economic growth with an additional 2.6 percent gain in average household income.[7] Moreover, accelerated agricultural growth has a large positive effect on real incomes of poor household groups, raising average real incomes of agricultural wage laborers and the rural non-farm poor by an additional 4.0 to 4.5 percent as agricultural growth spurs rural non-farm output and incomes. Real food prices also decline in this scenario, benefitting food-deficit urban poor and poor rural non-farm households.

Further analysis is needed to assess better dynamic aspects of growth, including rural-urban migration and possible positive agglomeration effects on productivity in urban centers. Nonetheless, the results presented in this paper strongly suggest that while productivity growth concentrated in non-agricultural sectors has substantial benefits in terms of increased total output and incomes, agricultural productivity growth remains essential for rapidly reducing poverty in Pakistan. Thus, **developing agricultural and rural labor markets** (as part of efforts to develop markets) and increasing the **efficiency of government institutions involved in raising crop and livestock productivity** have the potential to ensure that accelerated economic growth in Pakistan results in major welfare benefits for the poor.

[7] Such gains in agricultural productivity are possible, as witnessed by Pakistan's success with the green revolution in the 1960s, 1970s, and 1980s and significant yield gaps between Pakistan and other countries.

APPENDIX A: SPECIFICATION OF THE CGE MODEL

The description of the model is based on chapter 2 of Diao, et al. (2011)[8].

Consumer behavior

Following general equilibrium theory, representative consumers (i.e., households) and producers in our model are treated as individual economic agents. Representative consumers maximize their welfare or utility subject to a budget constraint, using a Stone-Geary utility function. Each representative household *h* in the model has their own utility function, in which *C* is the level of consumption of good *i*, *γ* is a minimum subsistence level of consumption of good *i*, and *β* is the households' marginal budget share (i.e., share of the next "dollar" of income spent on each type of good). Consumption-based utility is maximized subject to a budget constraint, in which *P* is the market price of each good, *Y* is total household income, and *s* and *ty* are marginal savings and direct income tax rates, respectively.

Producer behavior

Producers are defined at the sector level. Each representative producer maximizes profits subject to a given set of input and output prices. Following neoclassical theory, we assume constant returns to scale. Accordingly, a constant elasticity of substitution (CES) function is used to determine production:

$$X_i = \Lambda_i \left(\sum_f \alpha_{if} \cdot V_{if}^{-\rho_i} \right)^{-1/\rho_i}$$

where *X* is the output quantity of sector *i*, Λ is a shift parameter reflecting total factor productivity (TFP), *V* is the quantity demanded of each factor *f* (i.e., land, labor, and capital), and *α* is a share parameter of factor *f* employed in the production of good *i*.[9] The elasticity of substitution between factors *σ* is a transformation of *ρ* (i.e., σ_i=1/(1+ρ_i)). Profits *π* in each sector *i* are defined as the difference between revenues and total factor payments. Maximizing sectoral profits provides the system of factor demand equations used in the model.

Intermediate inputs are also used in the production process. In our model we assume Leontief technology when determining intermediate demand of individual goods and when combining aggregate factor and intermediate inputs. Thus, demand for intermediates is based on fixed input-output coefficients $io_{i,j}$ defining the quantity of good *j* used in the production of one unit of good *i*.

Behavioral functions governing international trade

Given observed two-way trade between countries for similar goods, we assume imperfect substitution between domestic goods and goods supplied to and from foreign markets. An Armington specification (i.e., CES function) (Armington 1969) in the presence of profit maximization with fixed world prices (small country assumption) is used to define the relationship between domestically-produced and imported goods. In an analogous way, profit maximization in the presence of a constant elasticity of transformation (CET) function determines the relationship between the quantity of goods produced for domestic and foreign export markets (at fixed world prices).

Equilibrium conditions

Full employment and factor mobility across sectors is assumed for labor and land, and fixed sectoral employment is assumed for capital. Assuming all factors are owned by households[10], household income *Y* is determined by the sum of factor- and non-factor income, which include public and foreign transfer (foreign remittances to households).

The determination of relative prices comes from the sector-specific commodity market equilibria, which require that the composite supply of each good *Q* equals total demand, as shown below:

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[8] Xinshen Diao, James Thurlow, Samuel Benin, and Shenggen Fan. 2011. *Agricultural Strategies in Africa: Evidence from Economywide Simulation Models*, revised book manuscript. 25 January 2011. Washington DC: IFPRI.

[9] Given the existence of by-products (i.e., multiple goods from a single sector) and the fact that the same good can be produced in different sectors, our model actually distinguishes between sectors (activities) and goods (commodities). However, in the chapter we simplify our exposition by using the two interchangeably.

[10] In reality, part of factor incomes, for example, the return to capital, can be owned by the government or foreign institutions. While this is allowed in the model that we actually implement in each case study, at this stage we ignore non-household factor ownership in order to simplify our discussion.

$$Q_i = \sum_h C_{ih} + N_i + G_i + \sum_{i'} (io_{i'i} \cdot X_i) + E - M$$

where Q_i states for production of good i, C_{ih} for the consumption of good i by household group h, N_i for investment demand of good i, G_i for public expenditures in good i, $\sum_{i'}(io_{i'i} \cdot X_i)$ for the intermediate consumption of good i, E for the export of good i, and M for the import of good i.

Government and investment demand

The government is treated as a separate agent with income and expenditures, but without any behavioral functions. Total domestic revenues R is the summation of all individual taxes. Tax rates are typically exogenous in a CGE model so that they can be used to simulate policy changes. The government may also receive income from abroad, such as via foreign grants/borrowing and from holding assets.

The government uses its revenues to purchase goods and services (i.e., recurrent consumption spending) and to save (i.e., finance public capital investment). We assume that the government expenditure G is determined exogenously, implying that an increase in government revenues causes the fiscal surplus to expand (or deficit to contract). The government also makes transfers to (and receives incomes from) households (e.g., social grants).

There are also no behavioral functions determining the level of investment demand for goods and services. The total value of all investment spending must equal the total amount of investible funds I in the economy. We therefore assume that value of N for each good i is in fixed proportion to the total value of investment. To determine the value of I we must define our macroeconomic closure.

Current account and macroeconomic closure

A CGE model is an empirical tool based on neoclassical general equilibrium theory in which there is no room for current account imbalances. However, CGE models are often calibrated to observed data for a country. Hence, Walras Law no longer holds unless we introduce real financial flows into the model, such as incomes from holding foreign assets or the government's foreign borrowing. Current account imbalances must be accounted for since they affect the real side of the economy via the relationship between exports and imports, and between savings and investment.

A country's current account balance is equal to its trade balance less net foreign incomes (*NFI)*. A country is therefore running a current account surplus whenever the sum of its trade balance and *NFI* is positive, in which case national savings exceed national investment and there is an accumulation of net foreign assets (*NFA)*. Total savings in the economy is the sum of all household savings and the government's recurrent fiscal balance.

Macroeconomic balance in a CGE model is determined exogenously by a series of "closure rules". The most important of these is the current account balance. While this is a substantive research topic within macroeconomics, it is treated as an exogenous variable within our single-country open economy CGE model. For example, one area of macroeconomics focuses on the dynamics of exports and imports, and explains how growth in *total* exports is the result of export-led growth strategies and undervalued exchange rates (see, for example, Mann 2002). In the same vein, it is possible to introduce a nominal exchange rate into a CGE model to act as a numeraire to convert international prices measured in foreign currency (e.g., dollars) into domestic currency units. However, the nominal exchange rate is unlikely to be chosen as a policy instrument to determine trade patterns. Instead, as discussed above, the behavioral function determining trade flows in the CGE model is at the sector-level, and the focus of the model is on the structure of exports and imports, rather than their totals.

Either total savings *S* or total investment *I* (but not both) should be determined exogenously. We call this choice the "savings-investment" closure, which is a term borrowed from macroeconomics. If the CGE model is "savings-driven" then *I* is automatically determined by the level of total available savings (i.e., $I = S - \Delta NFA$). Consistent with Equation 1 in which *s* is a fixed parameter, our model specification is savings-driven. Were we to choose an "investment-driven" closure, then total investment *I* would have been exogenously set at a fixed value or in proportion to a macroeconomic indicator (e.g., GDP), and total savings would be made endogenous by allowing marginal savings rates *s* to adjust proportionally for all households.

Finally, our treatment of the government balance is in fact the third closure rule in the model. We chose to make recurrent consumption spending *G* exogenous and allow the fiscal balance *FB* to adjust to changes in revenues *R* (at a fixed level

of absorption). An alternative would have been to allow recurrent spending to adjust to changes in revenues, while holding *FB* constant. In this case, government spending on individual commodities G would be in proportion to total spending.

Our current account closure fixes the national trade balance. The government closure implies that changes in revenues alter the fiscal balance (and hence public investment) rather than recurrent spending. In our savings-driven closure, total investment adjusts to the level of total savings. Finally, the original consumer basket is chosen as the model's numeraire, i.e., the consumer price index (CPI) is fixed.

The above discussion presents our core CGE model. It describes the interactions of various agents, such as households, producers, and the government, within a market-based economy. We capture sectors' technologies via input coefficients, and we allow these to adapt to relative price movements by allowing imperfect substitution within our production and trade functions. While capturing the structure and behavior of individual representative households, we maintain the macro-consistency of micro-level decision-making through our general equilibrium framework.

APPENDIX B

Appendix Table B.1—Value-added in real terms (Base in billion rupees, rest in % changes)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services
Livestock	1051.4	0.2	9.6	-0.1	0.1
Crops	883.0	9.7	0.3	-0.1	-0.3
Other Primary	384.3	-1.2	0.0	6.3	3.1
Textiles	217.7	5.1	-1.1	3.9	3.2
Other Industry	2139.0	3.8	-0.2	2.4	3.0
Transportation	1155.9	0.5	0.4	0.9	7.1
Other Services	4090.3	-0.1	0.0	0.6	9.1

Source: Model simulations.

Appendix Table B.2—Value-added in real terms – disaggregated (Base in billion rupees, rest in % changes)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Irrigated wheat	218.8	12.1	1.6	0.1	-3.7	10.6
Non-irrigated wheat	16.6	13.5	1.7	-3.5	-6.3	10.3
Rice IRRI	79.0	7.7	0.9	-0.1	0.2	8.7
Rice basmati	71.5	7.8	0.9	-0.1	0.2	8.8
Cotton (irr)	125.0	8.2	-0.4	0.3	2.7	11.6
Sugar cane (irr)	93.0	5.8	0.5	-0.3	2.3	9.1
Other field crops	161.0	7.7	0.2	0.5	0.6	9.5
Fruits/vegetables	118.0	14.4	-2.2	-1.4	0.2	10.1
Livestock (cattle, milk)	993.4	0.2	9.7	-0.1	0.1	10.0
Livestock (poultry)	58.1	0.3	9.5	-0.1	0.1	9.9
Forestry	30.4	-0.4	0.1	5.7	4.1	10.4
Fishing	52.4	0.4	0.6	-0.1	-0.7	10.1
Mining	301.5	-1.6	-0.1	7.4	3.7	11.5
Veg Oils	21.9	-1.5	-0.3	0.3	10.1	10.4
Wheat Milling	295.0	8.6	-0.2	0.0	0.5	9.2
Rice Milling (IRRI)	220.3	9.9	-0.1	-0.1	0.3	9.8
Rice Milling (basmati)	199.4	10.0	-0.1	-0.1	0.2	9.9
Sugar	83.2	6.7	-1.0	-0.4	2.6	8.9
Other food	44.9	10.0	0.1	-0.2	0.3	10.2
Cotton gin (lint)	12.2	9.7	-2.1	0.3	3.0	11.9
Cotton spin (yarn)	83.3	10.0	-1.1	2.0	0.5	12.1
Cotton weave (cloth)	44.8	2.2	-1.4	9.5	2.1	13.1
Knitwear	7.1	14.2	-1.1	-3.1	-1.5	11.5
Garments	31.4	-1.1	-0.9	-0.8	13.0	9.3
Oth Textiles	38.9	-0.4	-0.3	7.5	3.3	10.8
Leather	6.3	-0.4	11.6	0.0	-0.8	10.3
Wood	101.0	0.3	0.0	7.9	0.8	9.9
Chemicals	74.4	1.3	-0.6	1.6	7.9	10.6
Fertilizer	34.6	9.2	0.8	0.0	-0.5	10.0
Cement, bricks	108.1	0.0	-0.2	3.5	4.8	9.1

Appendix Table B.2—Continued.

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Petroleum refining	91.6	-0.5	-0.1	2.6	6.1	10.3
Other Manufacturing	452.0	-0.3	-0.3	6.4	2.9	10.0
Energy	145.9	0.5	-0.1	1.0	8.4	10.2
Construction	260.3	0.2	-0.2	2.5	5.8	9.1
Trade-wholesale	274.5	1.3	0.8	1.1	5.8	9.8
Trade-retail	1,196.1	0.4	0.3	0.3	8.2	9.9
Trade-other (rest, hotel)	359.3	-0.4	0.3	0.3	9.6	10.0
Transport-Rail	2.5	-0.2	-0.4	2.3	5.4	9.0
Transport-Road	811.4	0.9	0.5	0.9	6.5	9.7
Transport-Water	22.9	-0.8	0.0	-0.2	11.7	10.6
Transport-Air	85.2	-4.3	-1.3	0.5	15.4	12.0
Transport-Other	234.0	1.3	0.8	1.1	5.8	9.8
Housing	194.0	-0.3	-0.1	0.7	9.4	9.9
Imputed Rent	45.0	0.0	0.0	0.0	10.0	10.0
Business Services	659.0	-2.4	-1.0	0.0	14.7	10.7
Health care	95.7	-0.2	-0.2	-0.1	9.7	9.0
Education	44.8	-0.3	0.1	0.1	10.1	9.4
Personal Services	50.7	0.0	0.0	-0.1	10.0	9.9
Other Priv Services	84.5	-2.6	0.4	-2.5	17.9	12.5
Public Services	530.1	0.0	0.2	1.6	6.8	9.0
Finance and insurance	556.7	1.6	-0.1	1.7	6.2	10.0

Source: Model simulations.

Appendix Table B.3—Output prices (% changes)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sec-tors
Wheat	1.0	-9.6	2.5	-0.6	9.0	0.6
Rice IRRI	1.0	-6.0	2.6	-0.7	5.3	0.5
Rice basmati	1.0	-5.9	2.6	-0.9	5.2	0.5
Cotton (irr)	1.0	-8.1	2.3	-0.7	7.6	0.7
Sugar cane (irr)	1.0	-9.8	2.5	-0.3	8.3	0.4
Other field crops	1.0	-10.1	2.3	0.2	8.0	0.4
Fruits/vegetables	1.0	-10.9	2.1	0.5	8.3	0.4
Livestock (cattle, milk)	1.0	-0.7	-12.7	-1.4	14.5	0.3
Livestock (poultry)	1.0	0.2	-13.6	-1.5	14.2	-0.2
Forestry	1.0	-6.1	3.2	20.1	23.8	1.9
Fishing	1.0	1.1	0.2	-1.0	6.1	1.1
Mining	1.0	1.1	0.5	-6.2	5.4	1.0
Veg Oils	1.0	0.2	0.5	-2.6	3.5	1.1
Wheat Milling	1.0	-13.4	-0.2	-0.7	9.5	-4.3
Rice Milling (IRRI)	1.0	-6.6	0.0	-1.2	8.0	-0.9
Rice Milling (basmati)	1.0	-4.6	0.4	-0.9	5.4	0.0
Sugar	1.0	-9.6	0.3	-0.9	9.5	-0.8
Other food	1.0	-3.3	0.2	-0.8	4.9	1.3
Cotton gin (lint)	1.0	-7.3	1.4	-0.5	7.7	1.2
Cotton spin (yarn)	1.0	-2.7	1.0	0.9	2.4	2.2
Cotton weave (cloth)	1.0	0.2	1.1	-1.0	1.4	2.2
Knitwear	1.0	-0.3	1.1	-0.4	1.4	2.1
Garments	1.0	2.2	1.5	0.7	-3.8	1.3
Oth Textiles	1.0	1.0	0.7	-3.2	2.7	1.4
Leather	1.0	2.3	-6.3	0.3	4.0	0.3
Wood	1.0	1.4	0.6	-14.7	15.9	0.3
Chemicals	1.0	3.7	1.7	-2.5	-1.6	1.0
Fertilizer	1.0	15.8	3.1	-8.7	-4.2	0.9
Cement, bricks	1.0	2.5	1.0	-11.7	10.6	-0.1
Petroleum refining	1.0	1.2	0.8	-8.4	15.1	1.6
Other Manufacturing	1.0	1.2	0.5	-9.6	11.4	1.0
Energy	1.0	3.8	0.6	1.6	-5.2	1.5
Construction	1.0	2.5	1.2	-3.4	0.6	0.5
Trade-wholesale	1.0	7.8	4.5	6.0	-19.5	0.1

Appendix Table B.3—Continued.

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sec-tors
Trade-retail	1.0	18.8	12.7	15.1	-48.9	-0.9
Trade-other (rest, hotel)	1.0	1.4	0.4	0.8	-2.7	0.7
Transport-Rail	1.0	3.2	1.8	-2.6	-0.1	1.0
Transport-Road	1.0	4.7	2.8	0.4	-6.3	0.7
Transport-Water	1.0	0.6	1.2	-0.6	0.5	2.3
Transport-Air	1.0	1.3	1.4	-0.6	-0.2	2.0
Transport-Other	1.0	7.5	4.3	5.3	-17.7	0.2
Housing	1.0	-0.3	0.1	6.4	-7.4	0.4
Imputed Rent	1.0	2.4	1.0	0.3	-3.1	1.5
Business Services	1.0	-0.3	-0.4	1.2	-0.5	1.6
Health care	1.0	2.8	1.3	0.6	-5.2	0.4
Education	1.0	1.5	0.6	0.4	-3.2	0.8
Personal Services	1.0	2.1	0.9	0.1	-3.7	0.2
Other Priv Services	1.0	0.7	1.0	-0.5	0.2	2.0
Public Services	1.0	1.6	0.6	-1.3	-1.3	0.5
Finance and insurance	1.0	8.7	0.0	7.4	-15.9	1.0

Source: Model simulations.

Appendix Table B.4—Exports in real terms (Base in billion rupees, rest in % change)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Fruits/vegetables	11.5	45.2	-4.2	-3.7	-12.7	14.3
Livestock (cattle, milk)	2.6	2.3	47.1	1.4	-22.0	14.6
Fishing	10.4	-3.3	5.2	1.2	-22.3	17.3
Wheat Milling	0.4	45.9	2.4	0.0	-14.4	24.9
Rice Milling (IRRI)	49.6	57.9	5.3	2.2	-28.3	28.9
Rice Milling (basmati)	69.7	42.0	3.0	0.8	-18.8	23.4
Sugar	5.6	31.7	0.5	0.1	-12.6	15.8
Other food	25.5	32.4	4.5	0.4	-17.0	16.0
Cotton gin (lint)	3.6	50.5	-3.5	-0.6	-20.2	16.9
Cotton spin (yarn)	68.4	24.5	-1.0	-4.2	-4.7	12.8
Cotton weave (cloth)	242.4	2.8	-1.4	10.9	0.5	13.7
Knitwear	96.0	17.4	-1.3	-4.3	-2.8	12.6
Garments	104.9	-7.9	-2.7	-6.4	37.8	13.8
Other Textiles	47.7	-2.6	1.2	19.1	-3.4	15.0
Leather	57.8	-7.6	51.1	-3.9	-11.5	19.8
Chemicals	31.5	-5.0	-1.9	5.2	13.7	13.4
Petroleum refining	59.3	-2.1	0.5	20.7	-18.3	12.0
Other Manufacturing	147.7	-2.0	1.0	28.4	-15.4	12.9
Trade-wholesale	0.0	-12.3	-5.6	-11.3	66.5	14.8
Trade-retail	1.8	-28.4	-19.3	-25.4	322.9	17.2
Transport-Water	28.4	-1.2	-0.2	-0.5	12.9	10.7
Transport-Air	194.6	-6.1	-1.9	0.4	18.3	12.8
Transport-Other	0.3	-11.7	-5.3	-10.2	59.6	14.6
Health care	0.2	-4.7	-0.6	-2.7	24.4	13.2
Other Priv Services	242.1	-3.2	0.6	-2.9	19.8	13.4

Source: Model simulations.

Appendix Table B.5—Imports in real terms (Base in billion rupees, rest in % change)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Wheat	65.4	-17.9	5.9	0.3	20.7	5.2
Other field crops	9.9	-14.1	5.9	6.0	7.4	3.3
Fruits/vegetables	4.3	-11.2	3.8	6.1	4.2	3.2
Livestock (cattle, milk)	3.8	5.9	-15.3	4.0	9.6	3.3
Mining	284.7	2.5	-0.3	-6.4	10.4	7.1
Veg Oils	77.0	6.5	3.1	2.2	-5.6	5.4
Sugar	0.7	-1.7	1.2	3.5	-0.4	2.8
Other food	63.4	0.0	0.2	4.0	-1.1	3.8
Cotton gin (lint)	63.9	-0.7	2.9	6.4	-0.8	7.1
Cotton spin (yarn)	18.1	-2.7	-0.4	10.3	2.5	10.9
Cotton weave (cloth)	4.9	8.0	4.3	5.6	-11.5	5.2
Oth Textiles	3.1	9.9	1.8	-1.1	-6.1	3.8
Wood	3.7	3.6	-1.3	-30.9	50.4	3.3
Chemicals	107.8	4.6	0.7	2.2	1.5	9.5
Petroleum refining	172.7	3.6	1.7	0.7	4.3	8.8
Other Manufacturing	825.6	1.2	0.0	1.2	6.0	8.8
Trade-retail	18.4	65.8	38.6	55.7	-85.7	-0.1
Trade-other (rest, hotel)	0.3	3.3	-1.3	5.5	-3.5	4.8
Business Services	289.6	5.5	1.1	10.6	-12.0	6.7
Education	3.2	3.4	-1.2	3.8	-4.0	4.6
Personal Services	7.9	5.4	-0.2	2.5	-5.3	3.3
Other Priv Services	148.5	3.3	-0.1	1.8	0.5	6.1

Source: Model simulations.

Appendix Table B.6—Real wages (Index for non-capital base, 20% rental rate for capital in the base, rest in % change)

	BASE	Simulation 1 Crop	Simulation 2 Livestock	Simulation 3 Industry	Simulation 4 Services	Simulation 5 All Sectors
Labor - agric (own)-large	1.0	-8.8	2.8	1.3	13.4	10.7
Labor - agric (own)-med Sindh	1.0	-9.3	2.5	0.9	13.8	10.3
Labor - agric (own)-med Punjab	1.0	-8.7	2.3	0.9	14.0	10.8
Labor - agric (own)-med OPak	1.0	-6.6	3.7	1.6	10.2	10.9
Labor - agric (own)-sm Sindh	1.0	-8.7	2.5	0.7	13.6	10.5
Labor - agric (own)-sm Punjab	1.0	-7.7	2.5	0.7	12.7	10.8
Labor - agric (own)-sm OPak	1.0	-8.0	2.6	1.5	12.9	10.3
Labor - agric (wage)	1.0	-2.7	-4.0	-0.8	15.5	10.4
Labor - non-ag (unsk)	1.0	1.7	0.7	1.3	5.3	11.2
Labor - non-ag (skilled)	1.0	0.2	-0.2	-4.0	12.8	10.5
Land - large- Sindh	1.0	-10.1	2.7	0.8	14.8	10.0
Land - large- Punjab	1.0	-9.6	2.6	1.5	14.8	10.3
Land - large - OthPak	1.0	-8.7	3.3	10.8	19.7	10.9
Land - irrigated - med Sindh	1.0	-9.8	2.5	0.7	14.5	9.9
Land - irrigated - med Punjab	1.0	-9.4	2.2	0.5	14.7	10.2
Land - irrigated - med OthPak	1.0	-7.6	3.3	0.7	11.2	10.5
Land - irrigated - sm Sindh	1.0	-9.3	2.4	0.5	14.4	10.0
Land - irrigated - sm Punjab	1.0	-8.5	2.2	0.4	14.0	10.3
Land - irrigated - sm OthPak	1.0	-8.9	2.0	0.5	14.1	10.0
Land non-irrig - sm/m Sindh	1.0	-7.8	3.4	30.7	33.4	12.7
Land non-irrig - sm/m Punjab	1.0	-5.8	3.7	18.1	22.1	12.2
Land non-irrig - sm/m OthPak	1.0	-6.9	3.5	24.7	28.0	12.4
Water	1.0	-7.9	2.8	0.6	12.4	10.6
Capital livestock	0.2	0.7	-9.0	-1.9	17.8	10.1
Capital other agric	0.2	-8.0	2.5	4.8	15.9	10.8
Capital formal	0.2	1.8	0.4	-3.9	12.1	9.1
Capital informal	0.2	8.0	4.8	5.7	-11.5	10.0

Source: Model simulations.

Appendix Table B.7: Decomposition of the simulated changes in household income (% change by source)

		TOTAL	Lab_ag	Lab_agn	Cap_ag	Cap_fo	Cap_in	Lnd	Lvst	Transf
CROPTFP+10	HMLF	-2.4	-0.8	0.0	-0.5		2.1	-3.3	0.1	0.0
CROPTFP+10	HS0F	1.7	-0.4	0.1	-0.2		3.0	-1.0	0.1	0.0
CROPTFP+10	HAGW	4.3	-0.4	0.1			4.5		0.0	0.0
CROPTFP+10	HNFP	3.9	0.0	0.5			3.4		0.1	0.0
CROPTFP+10	HNFNP	3.8	0.0	0.3			3.4		0.0	0.0
CROPTFP+10	HURP	2.6	0.0	0.8			1.8			0.0
CROPTFP+10	HURNP	2.2	0.0	0.1		1.1	1.0			0.0
CROPTFP+10	HTOTAL	2.2	-0.2	0.2	-0.1	0.4	2.2	-0.5	0.0	0.0
LVSTTFP+10	HMLF	1.6	0.3	0.0	0.2		1.3	1.0	-1.1	0.0
LVSTTFP+10	HS0F	0.3	0.1	0.0	0.0		1.8	0.3	-2.0	0.1
LVSTTFP+10	HAGW	1.6	-0.6	0.1			2.7		-0.7	0.1
LVSTTFP+10	HNFP	1.5	-0.1	0.2			2.0		-0.7	0.1
LVSTTFP+10	HNFNP	1.7	0.0	0.1			2.0		-0.5	0.1
LVSTTFP+10	HURP	1.4	0.0	0.3			1.1			0.1
LVSTTFP+10	HURNP	0.8	0.0	0.0		0.2	0.6			0.1
LVSTTFP+10	HTOTAL	1.0	0.0	0.0	0.0	0.1	1.3	0.1	-0.6	0.1
INDUTFP+10	HMLF	2.2	0.1	0.0	0.3		1.5	0.5	-0.2	0.0
INDUTFP+10	HS0F	2.0	0.0	0.1	0.1		2.1	0.1	-0.4	-0.1
INDUTFP+10	HAGW	3.0	-0.1	0.1			3.2		-0.1	-0.1
INDUTFP+10	HNFP	2.3	0.0	0.0			2.4		-0.1	0.0
INDUTFP+10	HNFNP	1.6	0.0	-0.6			2.4		-0.1	-0.1
INDUTFP+10	HURP	1.0	0.0	-0.2			1.3			-0.1
INDUTFP+10	HURNP	-2.3	0.0	-0.4		-2.5	0.7			0.0
INDUTFP+10	HTOTAL	0.3	0.0	-0.3	0.0	-1.0	1.6	0.1	-0.1	-0.1
SERVTFP+10	HMLF	6.7	1.4	0.0	1.0		-3.0	5.3	2.1	0.0
SERVTFP+10	HS0F	2.8	0.9	0.3	0.3		-4.3	1.6	4.0	0.1
SERVTFP+10	HAGW	-2.4	2.2	0.4			-6.4		1.3	0.1
SERVTFP+10	HNFP	-0.7	0.2	2.5			-4.9		1.4	0.1
SERVTFP+10	HNFNP	-0.3	0.1	3.4			-4.9		1.0	0.1
SERVTFP+10	HURP	2.2	0.1	4.6			-2.6			0.1
SERVTFP+10	HURNP	8.3	0.0	1.8		7.8	-1.4			0.1
SERVTFP+10	HTOTAL	4.3	0.4	1.8	0.1	3.0	-3.2	0.8	1.3	0.1
ALLTFP+10	HMLF	9.6	1.1	0.0	0.7		2.6	3.9	1.2	0.1
ALLTFP+10	HS0F	8.8	0.7	0.6	0.2		3.8	1.1	2.2	0.2
ALLTFP+10	HAGW	8.9	1.5	0.9			5.6		0.7	0.2
ALLTFP+10	HNFP	9.3	0.2	4.0			4.3		0.8	0.2
ALLTFP+10	HNFNP	8.9	0.1	3.8			4.3		0.5	0.2
ALLTFP+10	HURP	9.3	0.1	6.7			2.3			0.2
ALLTFP+10	HURNP	9.0	0.0	1.8		5.8	1.2			0.2
ALLTFP+10	HTOTAL	9.0	0.3	2.1	0.1	2.2	2.8	0.6	0.7	0.2

Source: Model simulations.

Appendix Table B.8—Production – Elasticity of substitution between factors

Sector	Elasticity
Irrigated wheat	0.9
Non-irrigated wheat	0.9
Rice IRRI	0.9
Rice basmati	0.9
Cotton (irr)	0.9
Sugar cane (irr)	2
Other field crops	0.9
Fruits/vegetables	0.9
Livestock (cattle, milk)	0.9
Livestock (poultry)	0.9
Forestry	0.9
Fishing	0.75
Mining	0.75
Veg Oils	0.75
Wheat Milling	0.75
Rice Milling (IRRI)	0.75
Rice Milling (basmati)	0.75
Sugar	0.75
Other food	0.75
Cotton gin (lint)	0.75
Cotton spin (yarn)	0.75
Cotton weave (cloth)	0.75
Knitwear	0.75
Garments	0.75
Oth Textiles	0.75
Leather	0.75
Wood	0.75
Chemicals	0.75
Fertilizer	0.75
Cement, bricks	0.75
Petroleum refining	0.75
Other Manufacturing	0.75
Energy	0.75
Construction	0.75
Trade-wholesale	0.9
Trade-retail	0.9
Trade-other (rest, hotel)	0.9
Transport-Rail	0.75
Transport-Road	0.75
Transport-Water	0.75
Transport-Air	0.75
Transport-Other	0.75
Housing	0.75
Imputed Rent	0.75
Business Services	0.75
Health care	0.9
Education	0.75
Personal Services	0.75
Other Priv Services	0.75
Public Services	0.75
Finance and insurance	0.75

Source: IFPRI Pakistan CGE model.

Appendix Table B.9: Labor - Factor supply elasticity

	Factor supply elasticity
Labor - agric (own)-large	2
Labor - agric (own)-med Sindh	2
Labor - agric (own)-med Punjab	2
Labor - agric (own)-med OPak	2
Labor - agric (own)-sm Sindh	2
Labor - agric (own)-sm Punjab	2
Labor - agric (own)-sm OPak	2
Labor - agric (wage)	2
Labor - non-ag (unsk)	2
Labor - non-ag (skilled)	2

Source: IFPRI Pakistan CGE model.

Appendix Table B.10—Income elasticities of demand by commodity and household group

	Med/Large farm Sindh	Med/Large farm Punjab	Med/Large farm Other	Small farm Sindh	Small farm Punjab	Small farm OthPak	Landless Farmer Sindh	Landless Farmer Punjab	Landless Farmer OthPak	Waged rural landless farmers Sindh	Waged rural landless farmers Punjab	Waged rural landless farmers OthPak	Rural non-farm quintile 1	Rural non-farm quintile 2	Rural non-farm other	Urban quintile 1	Urban quintile 2	Urban other
Wheat	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Rice IRRI	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Rice basmati	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Cotton (irr)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Sugar cane (irr)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Other field crops	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fruits/vegetables	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Livestock (cattle, milk)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Livestock (poultry)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Forestry	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fishing	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Mining	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Veg Oils	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Wheat Milling	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Rice Milling (IRRI)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Rice Milling (basmati)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Sugar	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Other food	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cotton gin (lint)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Cotton spin (yarn)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Cotton weave (cloth)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Knitwear	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Garments	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Oth Textiles	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Leather	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

(cont…)

Appendix Table B.10—Continued.

	Med/Large farm Sindh	Med/Large farm Punjab	Med/Large farm Other	Small farm Sindh	Small farm Punjab	Small farm OthPak	Landless Farmer Sindh	Landless Farmer Punjab	Landless Farmer OthPak	Waged rural landless farmers Sindh	Waged rural landless farmers Punjab	Waged rural landless farmers OthPak	Rural non-farm quintile 1	Rural non-farm quintile 2	Rural non-farm other	Urban quintile 1	Urban quintile 2	Urban other
Wood	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Chemicals	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Fertilizer	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Cement, bricks	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Petroleum refining	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Other Manufac-turing	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Energy	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Construction	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Trade-wholesale	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Trade-retail	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Trade-other (rest, hotel)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Transport-Rail	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Transport-Road	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Transport-Water	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Transport-Air	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Transport-Other	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Housing	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Imputed Rent	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Business Services	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Health care	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Education	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Personal Services	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Other Priv Services	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Public Services	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Finance and insurance	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

Source: IFPRI Pakistan CGE model

Appendix Table B.11—International trade elasticities

	Armington Elasticity: Elasticity of substitution between imports and domestic output in domestic demand	CET Elasticity: Elasticity of transformation between exports and domestic supplies in domestic marketed output
	SIGMAQ	SIGMAT
Wheat	3	4
Rice IRRI	3	2
Rice basmati	3	2
Cotton (irr)	3	2
Sugar cane (irr)	3	2
Other field crops	3	2
Fruits/vegetables	3	2
Livestock (cattle, milk)	3	2
Livestock (poultry)	3	2
Forestry	3	5
Fishing	3	5
Mining	3	2
Veg Oils	3	2
Wheat Milling	3	2
Rice Milling (IRRI)	3	5
Rice Milling (basmati)	3	5
Sugar	2	2
Other food	3	5
Cotton gin (lint)	3	4
Cotton spin (yarn)	3	4
Cotton weave (cloth)	3	4
Knitwear	3	4
Garments	3	4
Oth Textiles	3	4
Leather	3	4
Wood	3	2
Chemicals	0.5	2
Fertilizer	0.5	2
Cement, bricks	0.5	2
Petroleum refining	0.8	2
Other Manufacturing	0.5	2
Energy	3	2
Construction	3	2
Trade-wholesale	3	2
Trade-retail	3	2
Trade-other (rest, hotel)	3	2
Transport-Rail	3	2
Transport-Road	3	2
Transport-Water	3	2
Transport-Air	3	2
Transport-Other	3	2
Housing	3	2

Source: IFPRI Pakistan CGE model.

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