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Abstract

The Peruvian economy has exhibited remarkable growth in the past 20 years. Good tax and monetary policies, along with comprehensive structural adjustment, which has attracted substantial foreign investment, are regarded as the pillars of this success. Notwithstanding the advances experienced on reducing poverty, lowering inequality and unemployment continue to be elusive targets for the Peruvian government and constitute main causes of social unrest. This paper assesses the impact of Peruvian public expenditures in education, health, and infrastructure on economic growth, poverty, and income distribution in the past 20 years using a Dynamic Computable General Equilibrium Model (DCGEM), which is an economy-wide model that describes the behavior of producers and consumers and the linkages among them.

JEL Codes: C68, H50, H51, H52, H54
Keywords: Computable general equilibrium models, public expenditures, health, education, infrastructure

1. Introduction[1]

Most economists would concur that the two most important means for the government to affect economic growth, poverty, and income distribution are taxation and expenditure policy. In the case of Latin America, the largest proportion of existing studies is oriented toward assessing the impact of taxation on growth and equity issues. Studies addressing the long-term impact of public expenditures on growth and income distribution are less common despite the fact that the majority of economists agree that changes in total government expenditures have an impact on aggregate demand in the short run. Studies on the longer-term impact on growth are less frequent and inconclusive.

The Peruvian economy has exhibited remarkable growth in the past 20 years. Good tax and monetary policies, along with comprehensive structural adjustment, which has attracted substantial foreign investment, are regarded as the pillars of this success. Notwithstanding the advances experienced on reducing poverty, lowering inequality and unemployment continue to be elusive targets for the Peruvian government and constitute main causes of social unrest.

This paper assesses the impact of Peruvian public expenditures in education, health, and infrastructure on economic growth, poverty, and income distribution in the past 20 years. In particular, the paper aims to identify the links that public investment in education, health, and infrastructure have with economic growth, unemployment, and income distribution.

In Peru, both the public and private sectors provide education and health services, as well as infrastructure. In fact, in many years private investment has surpassed public investment. The recent boom in tertiary education has been led by the private sector and is now being extended to primary and secondary education. A similar boom has occurred in health services. Expansion of telecommunications has also been the result of a major drive by private firms. Structural adjustment to open investment to the private sector has contributed to expansion of these services.

In recent years, the Peruvian government has implemented countercyclical public expenditure programs to mitigate the impact of the world financial crisis. Most of these programs have consisted of public investment in infrastructure, reducing the relative weight of public expenditures on education and health. This paper studies the impact of these shifts in public

[1] The authors thank the Inter-American Development Bank for financial assistance; Teresa Ter-Minassian and Gustavo Garcia for invaluable suggestions and editorial assistance; and participants of the Washington, DC seminar for their comments.

expenditures on growth and equity with the objective of identifying patterns that would contribute to improving future public expenditure programs.

A Dynamic Computable General Equilibrium Model (DCGEM) is the main analysis tool used to assess the impact of shifts on public expenditures on growth, poverty, and income distribution. In our study, the Peruvian DGCEM is an economy-wide model that describes the behavior of producers and consumers and the linkages among them. Seven Cobb–Douglas production functions depict the producers (agriculture and fishing; mining; manufacturing; electricity, gas, and water; construction; trade; and other services).

Consumers are described by five Linear Expenditure Systems (LES) that model the behavior of representative consumers of each quintile at the level of ten consumption categories in Peru's National Household Survey (ENAHO). The income generated by factors of production (capital and labor) and other sources of income (remittances from abroad, transfers, and other sources of income) is discriminated by income distribution categories (quintiles). This structure allows the analysis of the policy impact on poverty levels and income distribution as well as the impact on economic growth and employment.

The impact of public and private expenditures in education and health on growth, poverty, and income distribution is modeled by including capital expenditures on education and health as augmenting human capital factors in each of the sectorial Cobb–Douglas production functions. In a similar manner, the impact of public and private expenditures in infrastructure on growth, poverty, and income distribution is modeled by including augmenting physical capital factors in each production function.

To answer the questions posed by this study, we first describe the stylized features that characterize the long-term growth of the Peruvian economy. Next, we describe the evolution of poverty and extreme poverty levels together with the distribution of income and expenditures during the past 60 years. How unequal are the incomes of the poor and the rich, and what are the long-run trends of Peruvian income and expenditure distribution? Finally, we review the existing studies regarding the impact of government policy on growth, poverty, and income distribution in Peru since 1950. In particular, we review past work on government expenditure policies in much greater detail than past work on tax policy or any other form of government policy.

The rest of the paper is organized as follows. In section 2, we present a description of the DCGEM and the methodology used in this study. A key feature of the model is its transmission

mechanism between government expenditures and economic growth, poverty, and income distribution. This mechanism will be helpful in explaining the impact of different government policies on growth and equity. Section 3 presents the baseline and alternative scenarios used to quantify the impact of different public expenditure strategies on growth, poverty, and income distribution together with the results of the model simulations and their analysis. Section 4 presents conclusions and suggestions for alternative government expenditure policies.

2. Long-Term Growth Trends[2]

Analysis of the Peruvian economy growth trends over the past 60 years can be divided into four stages (Figure 1). The first stage is the period 1950 to 1962, during which growth was based on exporting primary goods. This period includes the governments of Manuel Odria and Manuel Prado and was characterized by the limited role of the public sector in the economy. Total investment measured as percentage of Gross Domestic Product (GDP) was relatively high compared with the post-war years despite the low levels of public investment that characterized this stage.

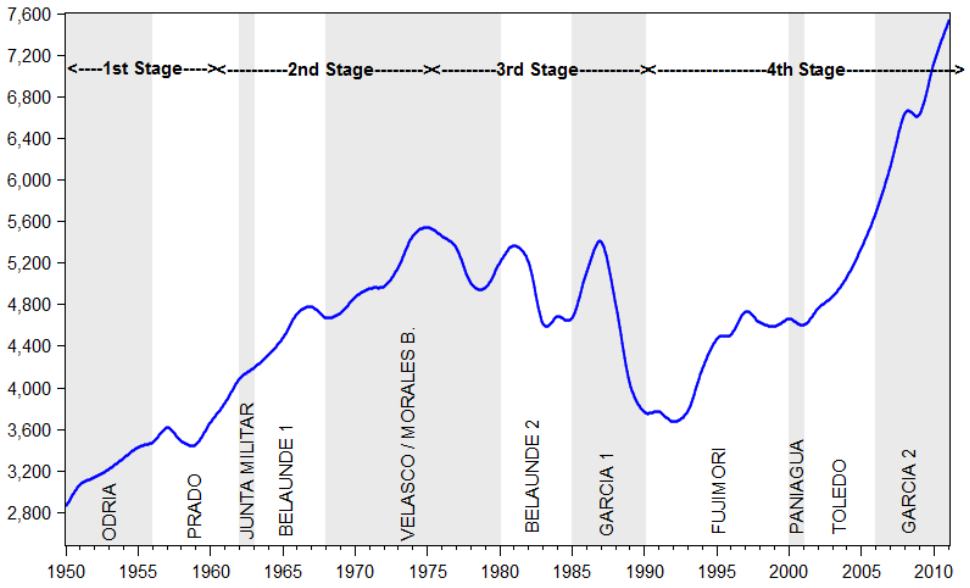
In 1963, this growth strategy came to an end with the election of Fernando Belaunde. During Belaunde's first term in office, the administration initiated a new stage in economic development that increased public sector policy in the economy. This stage was intensified by the military government of Velasco Alvarado and lasted until 1975, when Morales Bermudez took control of the military government. This stage emphasized industrialization through import substitution.

As a result, the role of the public sector in all spheres of economic activity increased substantially. The government increased the salaries of public employees and launched an ambitious public investment program concentrated on housing and road building. A protectionist trade policy was put in place, with low tariffs on capital goods and high tariffs on consumer goods that were produced domestically.

The anti-export bias of the new strategy resulted in a significant slowdown in the growth rate of exports. Decelerating export growth and much higher costs of servicing the foreign debt, which was used to finance higher government expenditures, led to a balance of payments problem by 1967 that resulted in a devaluation of 44 percent of the Peruvian currency.

[2] This section is based on Paredes and Sachs (1991).

Figure 1. Real GDP per Capita *(constant 1994 nuevos soles)*



Source: National Institute of Statistics of Peru (INEI).

A dispute with the International Petroleum Company, a subsidiary of Standard Oil, regarding an oil field in northern Peru triggered a military coup on October 3, 1968, that ousted Fernando Belaunde. An armed forces board, presided by General Juan Velasco, took control of the country.

The military government nationalized most foreign-owned enterprises, began a land reform that expropriated most large and medium-size haciendas in the coastal and Andean areas, ousting the landowners and giving the land to workers' cooperatives, and introduced major labor and education reforms. However, in the economic arena, the military government reinforced the import-substitution strategy initiated by Belaunde.

The outstanding growth rates registered during the first years of Velasco's administration were based on massive public investment financed with a significant increase of external public debt. The government's current expenditures and investment increased considerably, but revenue remained stagnant.

By mid-1975, a 20 percent drop in the terms of trade aggravated the fiscal imbalance. The deficit of the public sector reached 9.8 percent of GDP. Half the fiscal deficit was financed by domestic credit sources, causing a steep increase in inflation and a consequent rapid loss of

international reserves. In August 1975, the import-substitution strategy ran out of steam. General Francisco Morales Bermudez, the prime minister, deposed Velasco and took over the presidency of the military government.

Morales Bermudez began a third stage of the economic history of Peru since 1950. This stage lasted until 1990 and included the governments of Belaunde (second period) and Garcia (first period). This third stage was characterized by a complete lack of development strategy and by macroeconomic and social disorder.

In 1979, the beginning of operations of the Peruvian oil pipeline and an increase of 34 percent in the terms of trade came to the rescue of the Peruvian economy. The resulting export boom generated higher revenue from taxes and surpluses in public sector enterprises. Consequently, the budget deficit was reduced to 1.1 percent of GDP. This economic recovery eased the transition to democracy programmed by the military government. The election of Fernando Belaunde for his second term in 1980 marked the return of democracy.

The second term of Belaunde (1980–85) was characterized by populism and an undefined development strategy. As in the case of the Morales Bermudez administration, Belaunde did not fulfill his promises to liberalize the economy and reduce the participation of the public sector. Instead, the government began an expansive fiscal policy financed with foreign loans, confident that the export boom would last. However, by the end of 1982, international prices for Peru's main exports started to fall and international interest rates increased markedly. The budget deficit rose to 9.7 percent of GDP and inflation surged. The authorities financed these imbalances with international reserves while they lasted. The export boom ended and the government did not have the time or the will to put in place an alternative to the import-substitution strategy.

In 1984, the government initiated a new adjustment process, reducing expenditures and increasing excises on fuel products, but this process proved to be insufficient to comply with International Monetary Fund (IMF) targets. Consequently, the Belaunde administration could not obtain new foreign loans and began to lag behind in servicing its foreign debt. By 1985, as a result of the adjustment program and the depreciation of the exchange rate, the fiscal deficit was reduced to 2 percent of GDP, a current account surplus was reached and net international reserves increased, easing the transition to the newly elected president, Alan Garcia.

As a result of the bleak international situation and the policy decisions made during the Belaunde regime, from 1980 to 1985, per capita real GDP declined an average of 3.9 percent per

year, bringing with it an increase in the level of absolute poverty. The government failed to implement policies to replace the exhausted import-substitution strategy.

The first two years of the Garcia administration were marked by the implementation of a heterodox economic program that sought not only to reduce inflation and expand economic activity, but also to change Peru's economic structure. In his inaugural address, Garcia announced a unilateral reduction in foreign debt service to 10 percent of total export revenue and the freezing of the exchange rate, interest rates, and fuel prices for six months. Unlike previous orthodox stabilization programs, Garcia's proposal sought to promote growth by spurring the domestic market. At the same time, the program increased the level of protection for domestic industries, and fiscal expenditures were adjusted to increase people's purchasing power.

By the end of 1987, the heterodox program ran out of steam. The deficit of the nonfinancial public sector rose to 6.6 percent of GDP. Without new sources of external credit, the government turned to domestic credit, crowding out the private sector. In the last quarter of 1987, annual growth of real GDP decelerated to a bare 0.8 percent, monthly inflation rose to 7.4 percent, and net international reserves fell to US$43 million (less than one month of imports).

The distortion of relative prices led the Peruvian economy to an unprecedented stagflation. In 1988, GDP growth contracted 7.9 percent and inflation reached an annual rate of 1,722 percent. At the end of 1989, the rate of annual inflation reached 2,775 percent, GDP plummeted 11.3 percent, the fiscal deficit stood at 5.5 percent of GDP, and the net international reserves were nonexistent. This scenario occurred even though the country was not servicing a significant portion of its foreign debt, which had reached a level equivalent to 100 percent of GDP. In fact, by the end of 1989, arrears to the World Bank, the International Monetary Fund (IMF), and the Inter-American Development Bank (IDB) alone reached US$1.8 billion, almost 5 percent of GDP.

In the first half of 1990, the economic crisis intensified. Annual inflation accelerated from 2,775 percent for the whole of 1989, to 3,040 percent during just the first seven months of 1990. Price controls and subsidies through prices of public enterprises increased the already significant distortion in relative prices. Tax revenue fell below 4 percent of GDP, and net international reserves became negative.

But the crisis was not limited to the economy. The terrorist groups Sendero Luminoso (Shining Path) and Movimiento Revolucionario Tupac Amaru (MRTA)—which started their

attacks in the early 1980s—in 1989, reached an unprecedented level of activity that the ill equipped and strategically disoriented armed forces were unable to contain.

The new government of Alberto Fujimori, which took office in July 1990, initiated the fourth stage of the Peruvian economic history since 1950. This new stage departed significantly from the development strategies implemented previously. The strategy introduced by Fujimori has been a success and it has been maintained almost intact by the succeeding administrations until present day. This new development strategy, enshrined in the new Peruvian Constitution of 1993, has been followed by the administrations of Paniagua, Toledo, and the second period of Garcia. Even Ollanta Humala, the recently elected president that campaigned on a leftist policy, has dropped much of his earlier leftism—and adopted the development strategy initiated by Fujimori.

With tax revenue bordering 4 percent of GDP when Fujimori took office, his administration could not secure resources to finance its budget. The country was isolated from the international financial community, the Central Bank had no international reserves, and domestic sources of financing were negligible, with a monetary base that had shrunk to less than 2 percent of GDP. With no options left, on August 8, 1990, the Fujimori administration introduced a shock-treatment stabilization program. Simultaneously, the government announced the launching of major structural reforms to eliminate market distortions and to reintegrate Peru into the international financial community.

The results of Fujimori's shock treatment and structural reform were impressive. The immediate achievement was price stabilization. Hyperinflation was halted. Following the shock treatment in August, relative prices were realigned and annual inflation fell from 12,377 percent in August 1990 to 230 percent in August 1991.

One of the key elements of the stabilization program was the establishment of a public sector cash-management committee that matched expenditures to tax revenue on a monthly basis. This measure was coupled with the announcement that the Central Bank would no longer finance the fiscal deficit.

Structural reforms, the backbone of the new development strategy, consisted of opening up the economy and reducing the government's presence in the economy. The opening of the economy was intended to repair the damage of past protectionist policies. It has been the major instrument to modernize the economy and it goes far beyond a model of primary exports, a

notion used by several analysts to describe it (Gonzales de Olarte, 2000; Schuldt, 1994; Seminario, 1995).

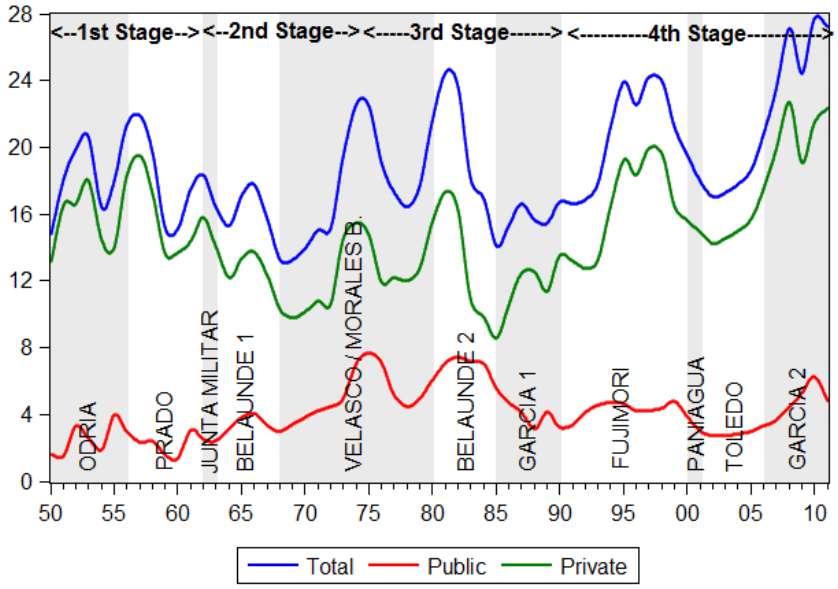
The reforms started with eliminating price controls and import licenses and abolishing all incentives to nontraditional exports, followed by simplifying and reducing the tariff structure. The maximum tariff was reduced to 25 percent from 84 percent, and by March 1991, the average tariff was 17 percent and has continued to fall since then.

Reducing government presence in the economy was another pillar of the new development strategy introduced by Fujimori. A massive body of legislation was passed in the first years of Fujimori's administration to establish a real market economy. Labor and land markets were liberalized. Privatization of public enterprises was accelerated to signal commitment to the market model and to attract foreign capital. Independent regulatory bodies for energy and telecommunications prices were put in place, and the tax agency (SUNAT) and the customs agency (SUNAD) were transformed into semi-autonomous agencies to improve tax collection and reduce evasion.

Another event that characterized Fujimori's administration was capturing the leader of the terrorist group Shining Path and a significant proportion of its high ranks. Though not an economic event, this capture was significant because it had an impact on confidence and investment.

As a result of these comprehensive reforms, income per capita recovered and investment rose from 15 percent of GDP in 1991 to a peak of 24 percent in 1997 (Figure 2). Exports surged and imports rose rapidly with liberalization and the substantial increase in investment. The balance of the external accounts was secured by inflows of foreign direct investment and debt refinancing.

Figure 2. Real Gross Investment *(as percent of GDP)*



Source: INEI and authors' calculations.

Agreements with multilateral institutions and the Paris Club countries were reached in 1993, thus reopening the government's and the private sector's access to foreign credit. Conversations with private creditors and non-Paris Club countries were initiated in 1993, and various programs were implemented from 1994 through 1996, allowing debt as means of payment in privatization, obtaining creditor acceptance for the government to assume the foreign obligations of companies being privatized, and terminating the numerous lawsuits initiated by hundreds of creditors in several jurisdictions. In March 1997, a Brady Plan was implemented with the voluntary participation of 99.5 percent of all remaining unpaid creditors. A total of US$12 billion of debt was exchanged for cash and bonds amounting to US$5 billion, with payments extended over a 30-year period at low interest rates. At the time, the savings represented 14 percent of GDP.

In 1998, the Fujimori economic model was put to a test. A severe El Nino, together with the default of the Russian foreign debt, created a severe shortage of credit lines that temporally interrupted the domestic production chain that led to a severe financial crisis. Instead of reducing taxes and increasing government expenditures, as in the past, the administration stayed put. For the first time in Peru's modern economic history, the theory of "the swings of the economic

pendulum" (González de Olarte, 2000), which postulated that each foreign crisis induced a collapse of the Peruvian economy, was broken.

From 1999 until present day, the administrations of Paniagua, Toledo, Garcia, and the current President, Humala have maintained the economic model inaugurated by Fujimori. Despite political turmoil generated by the transition period from Fujimori to Toledo, and several international crises, the Peruvian economy has experienced sustained growth fueled by increasing foreign investment and high international prices for mineral products.

3. Poverty, Income, and Expenditure Distribution Trends

This subsection examines changes in poverty, income, and expenditure distribution in Peru between 1950 and 2011. Assessing the long-term trends of poverty and equity in Peru is a difficult endeavor because of the scant statistical information available. Only with the introduction of the National Household Survey in 1996 has it been possible to obtain reasonable estimates of the levels of poverty and extreme poverty. Before 1996, the information is sporadic, corresponding to population census, special surveys on living standards measurements performed by the World Bank, and individual researchers.

Changes in methodology, different sample sizes, new population census, and changes in the definition of poverty make the assessment of the evolution of poverty and equity difficult.[3] For this study, we used the information available from different household surveys to estimate the evolution of each income decile for the period 1950–2011. The evolution of the seven major components of total GDP (agriculture and fishing, mining, manufacturing, electricity, gas and water, construction, trade, and other services), together with inflation rates, were used as explanatory variables of the behavior of each income decile for the years with available information. We then used econometric models to interpolate the evolution of each income decile for the period.

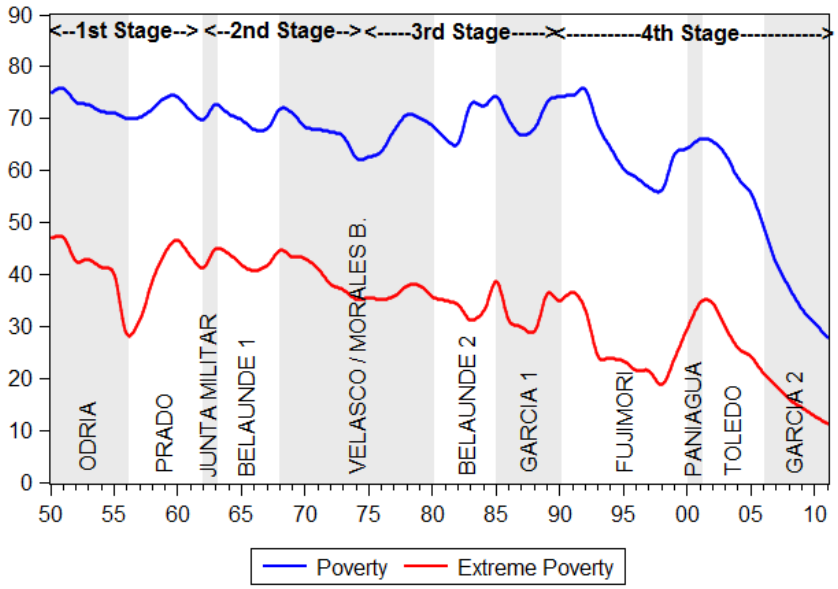
Results for the interpolated evolution of poverty and Gini indicators are presented in Figures 3 and 4. Webb (1977), in a seminal study titled "Government Policy and the Distribution of Income in Perú, 1963–1973", was the first author to quantify poverty and income distribution in Peru. His results were in line with the perception held by most of the population in 1970;

[3] The observed extreme volatility of the Gini Index is due to hyperinflation during Alan Garcia's first administration and the change of methodology introduced in the 2002 National Household Survey.

namely, that a high percentage of the population was poor and that the majority of them lived in rural areas, particularly in the highlands.

Webb's study opened the door for a more systematic treatment of Peruvian social problems, in particular poverty and income distribution. In 1985, with the help of the World Bank, the Peruvian government performed a Household Expenditure and Living Conditions Survey (ENNIV) that allowed the evolution of poverty, inequality, and other social indicator to be estimated for the period between 1961 and 1985. During Fujimori's administration, National Household Surveys were performed yearly, and through the years, coverage and methodology have improved.

Figure 3. Poverty and Extreme Poverty



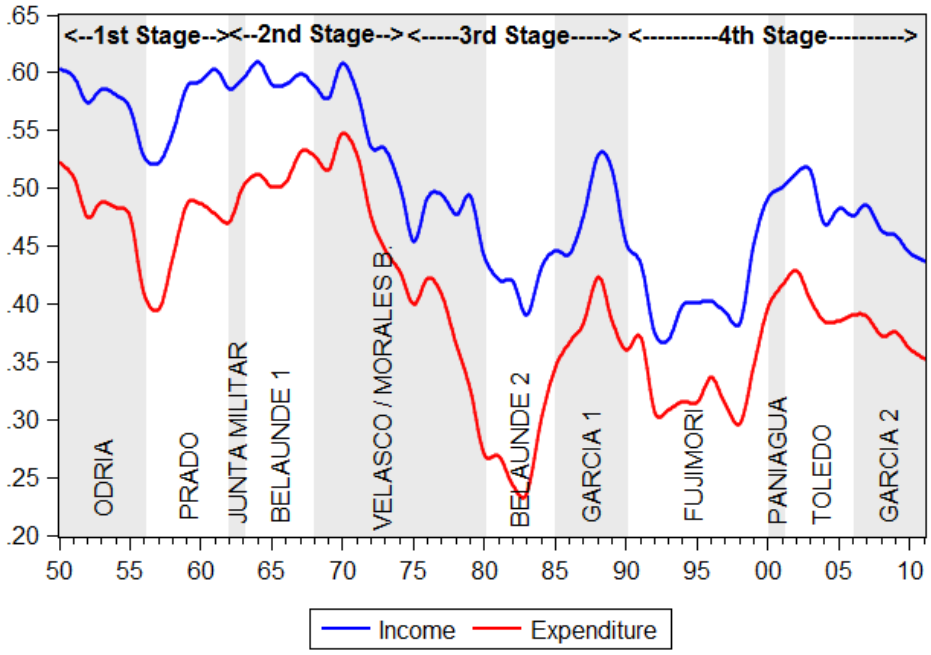
Source: INEI and authors' calculations.

The evolution of poverty and extreme poverty indicators reveals that Peru has traditionally been a poor country. More than 70 percent of the population qualified as poor under the World Bank poverty line standards for most of the period 1950 to 1970. During the early years of the Military government of Velasco, poverty levels declined; however, the recurrent economic crises during the Morales Bermudez and Belaunde administrations, and hyperinflation during the first administration of Garcia increased the poverty levels to figures similar to those registered in the 1950s.

It was only during Fujimori's administration that a sustained reduction of poverty was achieved. The severe adjustment program eliminated hyperinflation, and the introduction of focalized social programs assisted the poor. The world financial crisis of 1998 interrupted the downward trend in poverty. During the transition years of Paniagua's administration and the early years of Toledo's, poverty began to increase again as a result of stagnant economic growth and the suspension of many social programs that were initiated by Fujimori.

A substantial reduction in poverty levels has been achieved since 2002 as a result of the recovery of the world economy and the increase in international prices for Peru's main export products. This downward trend in poverty levels accelerated during Garcia's second administration. Better focused social programs and improvements in education and health that were initiated in the 1990s have contributed to these results.

Figure 4. Gini Index



Source: INEI and authors' calculations.

We infer two main conclusions from a historical analysis of poverty and income distribution indicators. First, poverty levels and income distribution are highly correlated with the economic cycle. Second, many of the public investment strategies—in particular better

access to education and health services and better transportation and telecommunication infrastructure, introduced in the 1990s have allowed for sustained reduction in poverty levels.

In fact, the downward trend in poverty, initiated during Fujimori's administration, reversed during the period 1999–2002, but returned to its downward trend once the world crisis and the internal political turmoil faded away. Recent data show that this downward trend has accelerated during Garcia's second administration. The Gini coefficient is also showing a downward trend.

However, poverty levels and inequality indicators are still at high levels compared with other countries in the region. This situation sheds some light on the question of the suitability of public expenditure strategies used during the last 20 years. Should public expenditure strategies be adjusted to produce better results? Should public expenditures on social protection for the poor be reduced to increase expenditures in education and health? To answer these questions, we require a deeper analysis of the strategies used by the Peruvian government in the past.

4. Public Expenditure Strategies

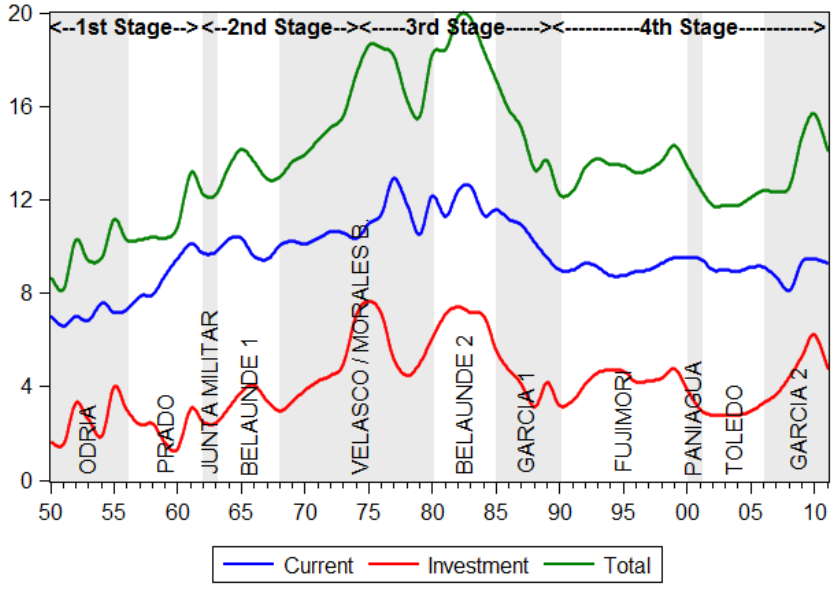
This section examines the evolution of the public sector in Peru between 1950 and 2011. In particular, it assesses the evolution of public expenditures on education, health, and infrastructure in terms of the priority given to each by different administrations.[4] Our analysis covers both current and capital expenditures. Aggregate data has been obtained from National Accounts. Sectoral data has been obtained from different sources. Individual sector analysis only covers the period 1970–2011 because of the availability of data.

The most striking result regarding Peru's public sector expenditures in the past 60 years is the decline of the public sector from a peak of 20 percent of GDP in 1982, during Belaunde's second term, to 15 percent during Fujimori's administration. This ratio was reduced even further during Toledo's administration largely because of a reduction in the level of public investment and the rapid economic growth attained between 2001 and 2006. Alan Garcia's second term restored the ratio attained by Fujimori thanks to a significant increase in public investment initiated as a countercyclical measure to confront the world financial crisis of 2008.

[4] For education, the analysis herein is based on a study by the World Bank (2001); for health, the analysis is based on studies by the Ministry of Health (MINSA, 2008) and the World Bank (2011); for infrastructure, the analysis is based on a study by the Instituto Peruano de Economia (IPE, 2009).

The evolution of the level of public expenditures as percentage of GDP is closely related to the economic model adopted by the authorities in charge (Figure 5). From 1950 to 1963, a period that includes the governments of Odria, Prado, and the Junta Militar, the economic model adopted by the Peruvian government was one of economic liberalism and fiscal conservatism. As a result, the participation of government expenditures in GDP was kept under 10 percent. Public investment was kept to a minimum to cover basic infrastructure and education and health. Total investment was done by the private sector, which experienced a significant flow of foreign direct investment, mostly in the primary export sectors (mining and fisheries). Despite adequate management of economic policy and rapid growth, distribution of income did not improve as growth of the modern sector outpaced the slow growth of agriculture.

Figure 5. Public Sector Expenditures *(as percent of GDP)*



Source: INEI and authors' calculations.

Garcia's first term had catastrophic consequences for the economy. His administration implemented inconsistent macroeconomic policies that at first created a false sense of prosperity and in the end created an even more serious crisis that required a series of adjustments that caused Peru's economy to collapse. The State was forced to shrink dramatically, and at the end of Garcia's administration, public expenditures as percent of GDP fell to 12 percent. The

compression of the public sector was certainly not a consequence of a premeditated government policy, but a consequence of hyperinflation.

The shrinkage of Peru's public sector preceded Fujimori's government, with most of it occurring under Alan Garcia's administration despite his publicly announced efforts to expand the scope of government by greater State spending and selective nationalization. When Fujimori took control of office in 1990, the public sector was so compressed that, in his first year, the administration's emphasis became an attempt to salvage the State by increasing government revenue (Webb, 1991).

During Fujimori's administration, public current expenditures were kept under control through large layoffs of public employees, privatization, and structural reforms. Public investment expanded significantly in roads, education, and health. The privatization program opened up foreign direct investment in the areas of telecommunications and electricity and water infrastructure.

The Paniagua's transition government and Toledo's administration reduced public investment as percent of GDP significantly. Political turmoil and the impact of the world crisis forced the government to curtail social programs related to assisting the poor and investing in education and health. In the last years of Toledo's administration, public current expenditures were increased moderately. In particular, the number of teachers was increased and public employees fired during Fujimori's administration were reinstated.

During the first two years of Garcia's administration, public expenditures remained stable as a percent of GDP. During the last three years of his mandate, because of the world financial crisis and as countercyclical measures, public expenditures were increased substantially, especially public investment in roads, education, and health. Total public expenditure as percent of GDP reached levels not seen since Fujimori's administration. This trend has continued with current Humala's administration.

4.1. Education

In Peru, education achieved notable successes from 1970 to 2011. Primary education now reaches almost all children. About 85 percent of the 12- to 16-year-olds enroll in secondary school and roughly 40 percent of the 17- to 25-year-olds enroll in tertiary education.

Based on a comprehensive study of education in Peru, the country has been able to attain high enrollment with a low level of public spending as a result of several factors:

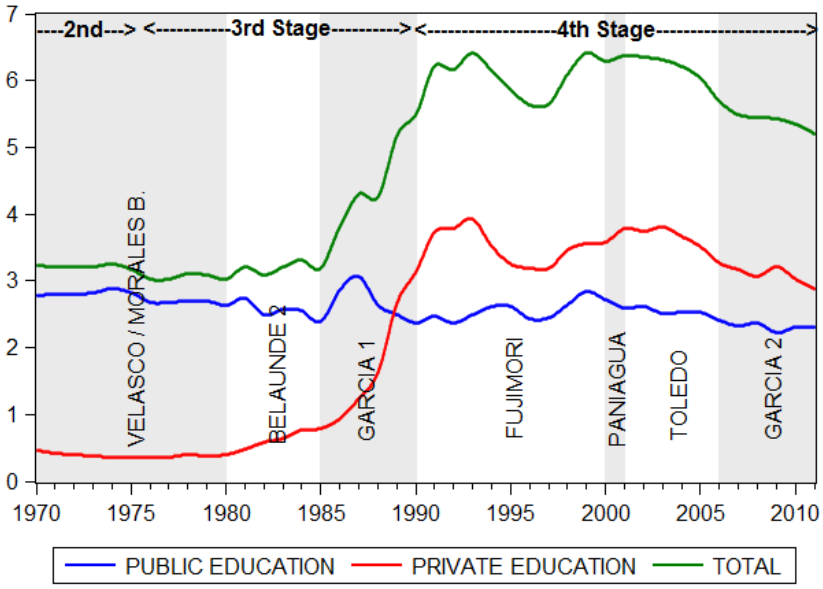
1. “achievement of near universal primary education before qualitative improvement;
2. containment of the growth of personnel expenditure, channeling the additional public resources to build up infrastructure and capacity; and
3. mobilization of high levels of household expenditure on education (total household spending on public and private education accounted for about 2 percent of GDP – much higher than the OECD’s 1.3 percent).

These factors operated in the context of what might be labeled a first generation of reform occurring in the early 1990s. This reform was characterized by rationalization of the public sector, regionalization of administration, deconcentration of social services, encouragement of private education, and extension of free and compulsory education (…).” (World Bank, 2001)

Peru has made impressive progress in extending education opportunities over the past five decades. Between 1950 and 1997, enrollment expanded 6.6 times, more than double the threefold increase in the population. Total enrollment grew from a mere 14 percent of the population in 1950 to 36 percent in 1997. As a consequence, over the period, the average education level of the population aged 15 and over increased from 1.9 years to 8.6 years, and the illiteracy rate was reduced to 11 percent from 58 percent. Female illiteracy was reduced to 18 percent from 70 percent, and rural illiteracy to 29 percent from over 60 percent.

However, Peru’s position is lower than most countries in the region when comparing the level of public spending on education as a percentage of GDP. Peru has been able to achieve an unusually high participation rate with a relatively low level of public spending on education. How has this been accomplished? Private sector participation has been the key factor in this achievement (Figure 6).

Figure 6. GDP Education Sector *(as percent of GDP)*

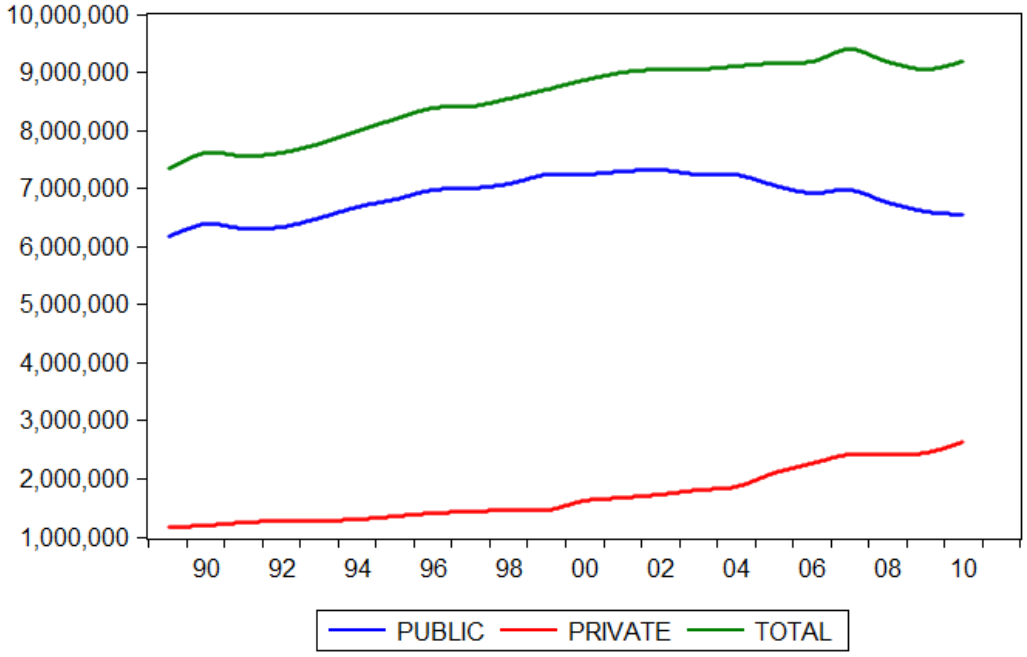


Source: INEI and authors' calculations.

The Constitution of 1993 extended compulsory and free education from primary to secondary school. A new law that encourages the establishment of private schools is a complement to the need to contain public spending and the constitutional mandate for expanded compulsory education. This legal framework, combined with retrenchment of education administrators and teachers, has led to a rapid growth in private schools. This supply has met the demand of parents who have grown weary of frequent closing of public schools due to teachers' strikes in the early 1990s, who consider the quality of public education unsatisfactory, and who can afford to pay for private schools.

Between 1990 and 1997, enrollment in private schools (Figure 7) grew by 62 percent in preschool, 9 percent in primary education, 28 percent in secondary education, and 37 percent in tertiary non-university education. This outpaced the rate of increase at these levels in the public sector, which grew only by 34 percent in initial education, 8 percent in primary education, 10 percent in secondary education, and 25 percent in tertiary non-university education.

Figure 7. Enrollment in All Levels *(number of students)*



Source: INEI and authors' calculations.

The overwhelming majority of private school students are from the richest consumption quintile of the country. A significant percentage of the fourth quintile also chose private schools. By contrast, less than 1.5 percent of students from the poorest quintile of all age groups were in private school.

Public spending on education fluctuated widely throughout the period under analysis. Between 1970 and 1997, public expenditures on education peaked in 1972 at 3.7 percent of GDP, falling to the lowest point at 2.2 percent in 1988, and recovering to 2.8 percent in 1997. The steep decline in public spending on education in the late 1980s reflected the extremely volatile macroeconomic environment. In 1988, when GDP contracted by 8.4 percent in real terms and total government expenditures by 29 percent, total public spending on education declined disproportionately by 40 percent.

The recovery of public spending on education in the 1990s started from this extremely low base in the late 1980s. The overall trend in the 1990s is a reversal of that in the 1980s: education expenditures increased at a higher rate than that of GDP or total government expenditures. Consideration for fiscal balance, however, has led to a gradual approach to increasing public spending on education. The enormous fluctuation in public expenditures on education over time,

nonetheless, reflected deep-seated instability and unpredictability in resource allocation, which made it difficult for strategic planning and undermined continuity of projects.

Capital investment increased to 15 percent of total public expenditures on education from 1.4 percent between 1990 and 1994, and then gradually fell back to 8 percent in 1999. Spending on other capital goods also increased, to 2.1 percent from 1.4 percent. Spending on goods and services as a percentage of total education expenditures more than doubled to 10 percent from 4 percent, and other recurrent costs also more than doubled to 1.8 percent from 0.7 percent. It should be noted, however, that the fluctuation in non-personnel education expenditures still bore the mark of unpredictability, which undermines planning and implementation.

By contrast, total personnel costs (remuneration and pensions) increased by 64 percent, substantially below the 94 percent increase in total public expenditures. As a result, the percentage share of personnel costs declined to 78 percent from 92 percent of total public spending during the period between 1990 and 1997.

Between 1990 and 1997, per student recurrent public spending steadily increased at all levels. It grew by 70 percent in preschool, 87 percent in primary education, 71 percent in secondary education, 79 percent in tertiary non-university education, and 335 percent in university education. While the percentage increase was impressive, it started from a very low base.

In Peru's public education system, there are some 248,000 primary and secondary school teachers. While progress has been made in the supply of qualified teachers, the key question is whether there is a particular pattern in the deployment of unqualified teachers and the potential impact on the quality of education. Teachers' average monthly salary of 646–689 soles is more than twice the minimum wage. Teachers' salaries were hard hit in the 1980s, but their remuneration in real terms steadily recovered in the 1990s.

Saavedra and Diaz (1999) found that teachers' relative position eroded by 30 percent between 1986 and 1992, but other professionals' relative earnings declined by 16 percent between 1992 and 1996, so that for the whole decade 1986 to 1996 teachers' earnings deteriorated by 10 percent compared with other professionals.

In summary, there has been significant progress in education in Peru over the past 20 years. The role played by the private sector has been significant. Government investment in education has helped to increase coverage to most of the population. However, quality of public education is low compared to private education or public education in other countries in the

region. The gap between private and public education is increasing and is having an impact on income distribution. Decentralization of education to regional governments and increasing current expenditures (i.e., increasing teacher's wages) at the cost of reducing capital expenditures has not produced tangible results.

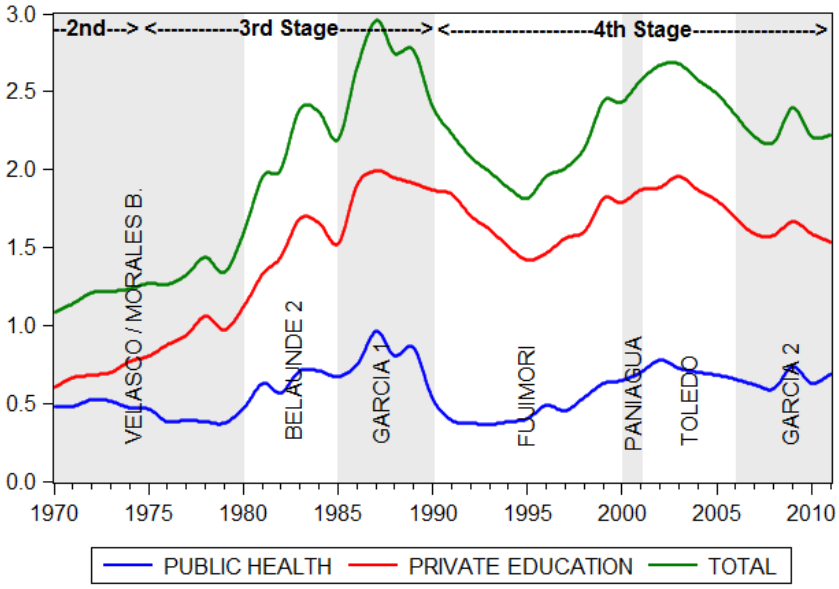
4.2. Health

After the economic crisis in Peru in the late 1980s, a significant pro-poor expansion of the country's health infrastructure in the 1990s was instrumental in increasing preventive and primary health care expenditures.

Peru's famously high levels of infant mortality are concentrated among the poor – two-thirds of infant deaths occur in the 40 percent poorest households. In recent years, health outcomes have begun to improve, with infant mortality and child malnutrition, for instance, having fallen by a third after 1992.

This improvement is partly a result of the overall improvement in income and living conditions that followed the economic collapse of the late 1980s and early 1990s, which was caused by hyperinflation and terrorism. It is also a result of the rapid recovery in the health sector from that collapse – public and private spending in health rose by over 50 percent in the three years after 1994. The improvement in health status also coincides with the introduction of a number of reforms in the health system aimed at improving health care for the poor.

Figure 8. GDP Health Sector *(as a percent of GDP)*



Source: INEI and authors' calculations.

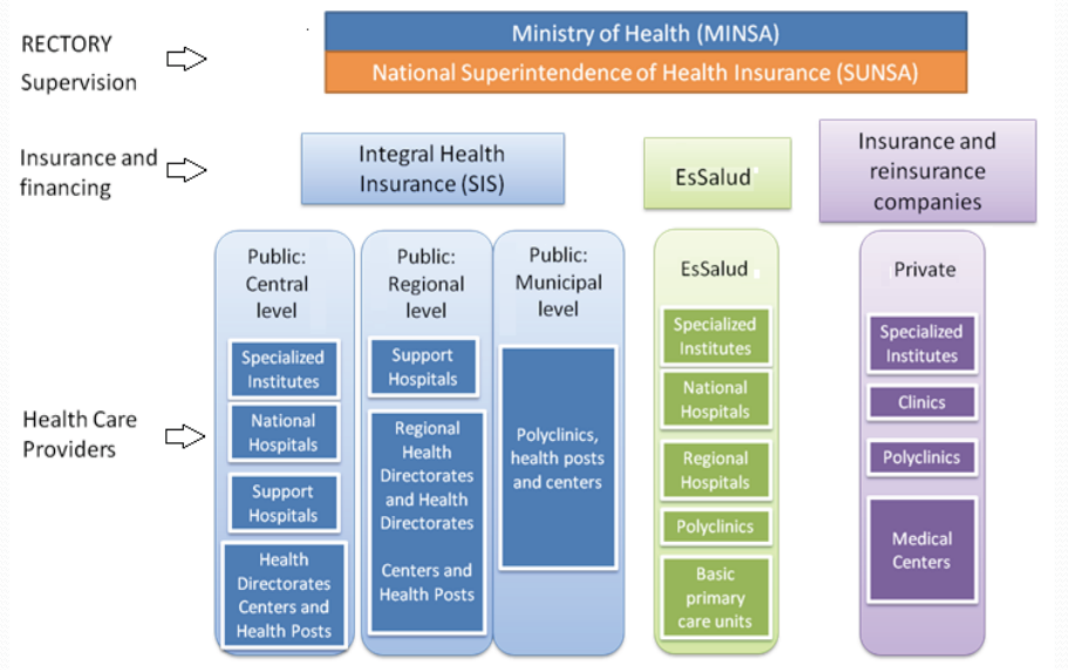
The provision of public health suffered enormously during the years of economic collapse and terrorism. By 1992, many health centers had closed and, those that remained open had no supplies and a poor quality of service. At the same time, many health professionals were out of work.

As economic growth was reestablished and the proceeds from privatization eased the fiscal constraint, the government assigned new funds to rehabilitate the health sector. In an effort to reach the population that had been exposed to terrorism in the poor areas of the highlands, government sought new ways to provide services. It also sought to target the new programs according to regional poverty levels.

The public sector infrastructure for primary care expanded greatly during Fujimori's administration. FONCODES (Peru's social investment fund) alone built or rehabilitated over 1200 clinics – other agencies also contributed to this expansion, increasing the number of clinics by 51 percent in the four years 1995–98). The new programs then became crucial to staff these clinics by financing salaries for one thousand health workers. The glut in the labor market for health workers was taken advantage of by creating a system of renewable temporary contracts that avoided the rigidity of civil service contracts. The new programs also became crucial to

determine the priority areas and the system of work in the primary clinics. The structure of Peru's health sector is presented in Figure 9.

Figure 9. Structure of Peru's Health Care System



Source: Seinfeld (2009).

Within the national accounts, only the activities of SIS (Integral Public Health Insurance System) are considered public health spending; the National Health Insurance Institution (EsSalud) is considered part of the private sector. As a result, private investment in health is substantially higher than the public sector's share.

Peru's health sector has seen major advances in recent decades; however, there are still significant deficiencies, in particular, the low budget allocated to health (5.9 percent of the total budget; 1.6 percent of GDP). Inequality is a problem that the health sector still faces, and targeted spending is needed to consolidate and improve care for the poorest people in the country. Fragmentation leads to poor use of scarce resources, and thus inefficiencies need to be resolved. Increased out-of-pocket spending to cover treatments is having a negative impact on people's health, especially for the poor.

It seems that the factors that helped reduce mortality rates over the past decade did not help reduce the persistently high nutritional risk faced by children in Peru,[5] especially in poor families. Such inequalities demonstrate the need for studies that can help elucidate the factors behind the continually high nutritional risk faced by Peruvian children, and also identify ways to better help public programs or policies to reduce the problem. This is particularly crucial when considering international evidence on the negative effect that nutritional deprivation during pregnancy and the first two or three years of life has on a child's future performance in school and in the labor market (see, for instance, Behrman, 2001).

4.3. Infrastructure[6]

We define "infrastructure" as the basic physical and organizational structures needed for the operation of a society or enterprise. In particular, we refer to the physical components of interrelated systems providing commodities and services essential to enable, sustain, or enhance living conditions. For this study, we typically refer to the structures that support a society, such as roads, bridges, water supply, sewers, electrical grids, telecommunications, and so forth. Peru's national accounts include electricity, gas, and water, and transportation and communications in infrastructure sectors.

Public investment in infrastructure in Peru has been volatile and low compared with other economies in the region. Its volatility has been associated with the many economic adjustments put in place by the various administrations. Public investment has been the first variable to be adjusted during economic crises.

During the 1970–84 period, public investment in infrastructure oscillated around 2.0 percent of GDP. This ratio declined even further during the 1985–90 period as a result of the economic collapse during Garcia's first administration (Figure 10).

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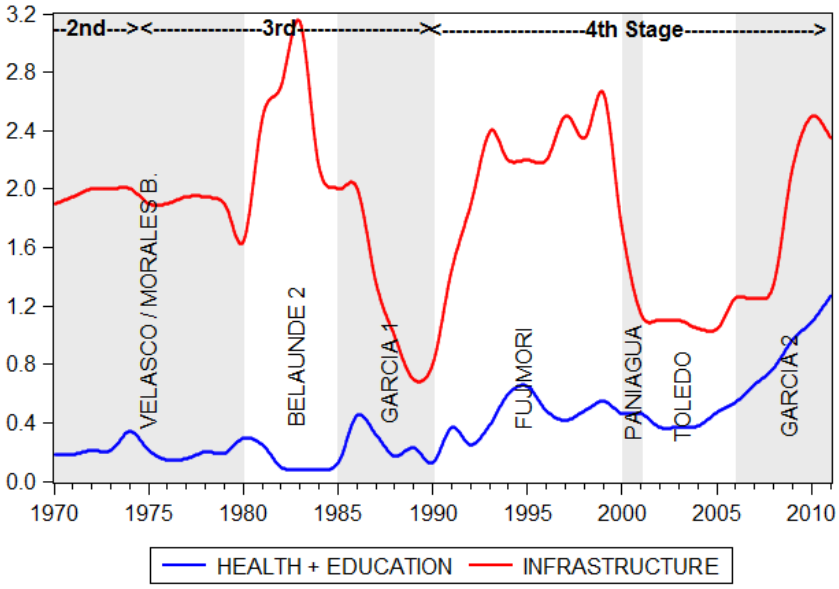
[5] The chronic malnutrition rate for children in the poorest quintile in 2000 was 54 percent. Malnutrition rates for the poorest and richest quintiles fell during the period, but the reduction was higher in the richest quintile.

[6] This section is based on IPE (2009).

Figure 10. Public Investment *(as a percent of GDP)*

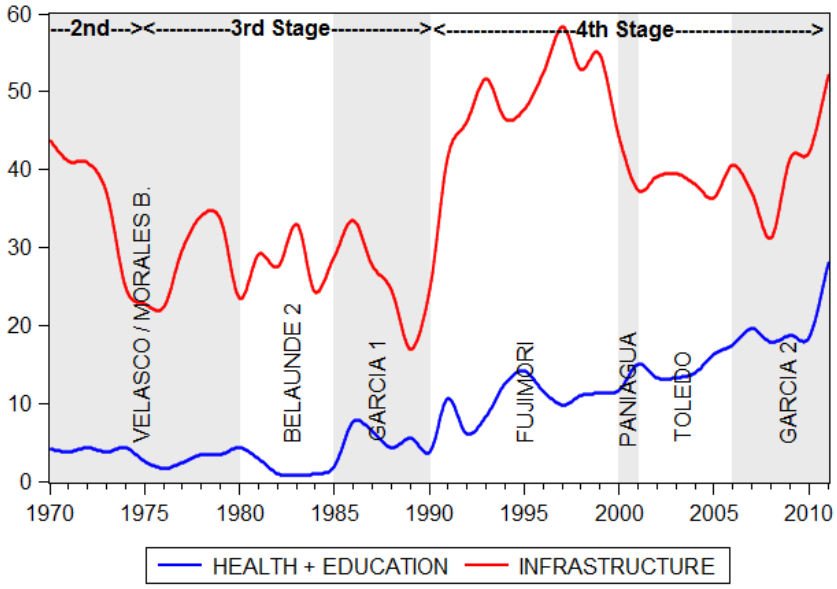


Source: INEI and authors' calculations.

During the 1990s, public investment in infrastructure, education, and health recovered significantly. Public investment in infrastructure as percent of GDP was higher than in the 1980s, with an average level during the 1992–99 period of 2.6 percent of GDP. Public investment in education and health increased similarly. Within infrastructure more resources were allocated to roads and hydroelectric projects, complemented by higher levels of private investment in infrastructure as a result of the privatization program initiated by Fujimori's administration.

During the period from 2000–08, which corresponds to the administrations of Paniagua, Toledo, and the early years of Garcia's second term, public investment in infrastructure was reduced significantly (Figures 10 and 11) compared with the levels during Fujimori's administration. The ratio of public investment in infrastructure to GDP declined to an average of 1.0 percent during this period. When measured as percent of total public investment, the share of public investment in infrastructure also declined significantly during this period (Figure 11). The change in public investment strategy followed an increase in private investment in roads, electricity, and telecommunications.

Figure 11. Public Investment *(as a percent of total public investment)*



Source: INEI and authors' calculations.

In the last three years of Garcia's administration, and as a consequence of the world financial crisis, public expenditures increased substantially. In particular, expenditures on infrastructure, education, and health projects were implemented as part of countercyclical expenditures to palliate the world crisis.

A historical analysis of public investment reveals clear changes in strategy over the 40 year period. From 1970 until 1990, there was no clear strategy regarding public investment in infrastructure, education, or health. During this period, recurrent economic crises dictated the low and volatile levels of public investment. From 1991 until 1999, there was a significant change in strategy, and public expenditures were oriented toward transportation, energy, education, and health. This strategy was complemented with increased participation of the private sector in these areas. From 2000 until 2008, there was another change in strategy. Public investment as percent of GDP was reduced in general. Investment in infrastructure declined, and priority was given to other areas, such as education and health. Private investment in infrastructure supplemented public investment, covering some of the reduction. The government decided to increase current expenditures in education, with higher wages for teachers and an increase in the number of public employees. With the world financial crisis in 2008, the strategy

changed again, and public investment as percent of GDP was increased again. This time the motivation was countercyclical measures to compensate for the decline in foreign demand.

From the analysis we present in the previous sections, it is clear that public investment in the past 40 years has played an important role in the long-term growth of Peru`s economy. It is evident that, after the collapse of the economy in the late 1880s, infrastructure needed a complete overhaul. In particular, investments in roads and electricity were priorities. It is most likely that the economic rate of return in the short term was higher in infrastructure than in education and health. However, after the year 2000, with a privatization program in place and with vigorous participation of the private sector, it is not clear if the economic rate of return for infrastructure spending was still higher than investment in education and health. Education and health investments have longer maturity terms than investments in infrastructure. Once the most pressing needs in infrastructure have been solved, it becomes more difficult to evaluate the relative importance of prioritizing infrastructure over education and health.

In the next sections we present a methodology that could help to answer these sorts of questions and help implement a strategy for public investment in infrastructure, education, and health.

5. Methodology

There is ample anecdotal and correlational evidence suggesting that infrastructure, education, and health expenditures are related to economic growth. However, most of this evidence is presented in isolation, whereas expenditures in these areas are correlated among themselves. Therefore, it is difficult to assess the substitutability, complementarity, and trade off impact of them on economic growth, poverty, and inequality. The design of proper public policies is closely linked to the ability to simultaneously assess their impact on growth, poverty, and inequality in order to determine the relative importance of the timing and level of expenditures.

In this section, we present the methodology used to simultaneously assess the impact of different types of infrastructure, education, and health expenditures on economic growth, poverty, and inequality**.** A DCGEM,[7] implemented specially for this study, is the main analysis tool used to simultaneously assess the impact of public and private investment on Peru`s economy. The time horizon of our analysis is 1992 to 2011. The hyperinflationary period in Peru

[7] For a description of DCGEM methodologies, see Burfisher (2011).

prior to 1992 limited the time horizon of our analysis. The definition of different economic scenarios that measure the deviation of model variables against the baseline solution is the technique used throughout this study.

5.1. The Model

The DCGEM comprises seven economic sectors:

1. agriculture and fishing
2. mining
3. manufacturing
4. electricity, gas, and water
5. construction
6. trade
7. other services

Other services comprises four sub-sectors:

1. transportation and communications
2. education
3. health
4. the rest of the other services

The model is structured in nine blocks that are standard in general equilibrium models:

1. population
2. supply
3. demand
4. income
5. prices
6. fiscal
7. balance of payments
8. monetary
9. equilibrium

An overall view of the model is presented in Figure 12 on page 33.

The **population** block describes the dynamics of 16 age brackets based on net mortality rates and overall fertility rates. Total population, total labor force, and number of household units are the main output variables of this block.

The **supply** block is characterized by two-stage Cobb–Douglas production functions, encompassing three production factors (intermediate consumption, capital, and labor) for each of the seven economic sectors. The first stage Cobb–Douglas describes *gross production* based on *intermediate consumption* and *value added*. For each sector, the second stage Cobb–Douglas describes *value added* as a function of capital and labor. Value added is decomposed into direct

taxes, wages, operating surplus, and depreciation. In turn, each type of income (wages and operating surplus) is distributed among five income categories (quintiles).

The **demand** block encompasses private consumption expenditures, government consumption, public and private investment, exports, and imports of goods and services. The components of the demand block, except the private consumption expenditures, are linked to other blocks of the model. Government consumption and public investment are linked to the fiscal block. Exports and imports of goods and services are linked to the balance of payments block. Private investment is linked to the equilibrium block to close the balance between total investment and total savings. Five Linear Expenditure Systems (LES) characterize consumer behavior of each quintile of the population. Each LES explains the allocation of total expenditures for a given quintile among the 10 different categories of consumption, reported on the annual Household Expenditure Survey, given their corresponding relative price indices. The system of five LES brings together micro data with aggregated national account data to guarantee the general equilibrium nature of the model.

The **income** block describes income distribution among the five income quintiles for each source of income. The sources of income correspond to the wages and operating surplus of each of the seven economic sectors included in the model and remittances and other personal income. Tax incidence of direct tax is taken into account to arrive at disposable personal income of each quintile. Then standard modeling of marginal propensities to save for each quintile is used to arrive at the allocation of total disposable personal income on savings and personal consumption expenditures.

The **prices** block describes the dynamics of the price indexes of the 10 consumption categories, the seven supply economic sectors, and the demand price deflators of government consumption, investment, exports, and imports. Price dynamics are explained in terms of import prices, exchange rate, terms of trade, and level of public sector domestic borrowing requirements.

The **fiscal** block comprises different direct and indirect tax revenues together with different categories of current and capital government expenditures. On the revenue side, tax revenue for direct taxes is estimated from the tax income by quintile described in the income block. Tax revenue for indirect taxes and import duties are estimated using the component of the demand block and the intermediate demand of the supply block. The expenditure side includes expenditures on wages and other current expenditures, including interest payments. Capital

expenditures and their allocation among economic sectors are treated as exogenous variables. Estimation of public borrowing requirements and their financing with domestic and foreign debt complete the fiscal block.

The external sector component of the model plays an important role. This component encompasses the dynamics of exports and imports of goods and services together with the different items of the balance of payments. Terms of trade and exchange rate evolution are key factors explaining the export boom of recent years.

The closure of the model is done through three equilibrium relationships. The first is the equilibrium of total savings (private, public, and foreign) and total investment. The second is the equilibrium between real supply and real demand for each of the seven economic sectors. Equilibrium is reached by adjusting the capital stock capacity utilization parameter of each production function. In turn, the capacity utilization parameter adjusts the level of employment used by each sector. Finally, the third equilibrium relationship is that between nominal supply and nominal demand. In this case, equilibrium is established by adjusting the price deflator of each economic sector.[8]

5.2. Impact of Education, Health, and Infrastructure Capital Expenditures on GDP Growth

In the following paragraphs we describe the capital expenditures transmission mechanism of the Peruvian DCGEM implemented to study the impact of education, health, and infrastructure on economic growth, employment, poverty, and income distribution.

Our starting point to describe this transmission mechanism is the Cobb–Douglas production function:

$$Y = A\ (K)^{a}\ (L)^{b}$$

Where:

Y is GDP

K is Capital Stock

L is Labor Force

And $a+b = 1$ to have constant returns to scale.

[8] A more detailed description of the DCGEM is presented in Appendix 2 together with the estimation results of the main behavioral equations of the model. The complete set of equations and data based in Eviews 7 can be requested from the author at jorge.baca@gmail.com.

To account for the skills of the labor force, the production function is adjusted to:

$$Y = A\ (K)^a\{(S)^cL\}^b$$

Where S is a skill index (literacy rate)

Investment in education, health, and infrastructure translates into increases in their corresponding capital stocks:

Education Capital Stock	$K_E(t+1) = (1-d_E)*K_E(t) + I_E(t+1)$
Health Capital Stock	$K_H(t+1) = (1-d_H)*K_H(t) + I_H(t+1)$
Infrastructure Capital Stock	$K_{In}(t+1) = (1-d_{In})*K_E(t) + I_{In}(t+1)$

We postulate that levels of education and health capital stock augment the productivity of the labor factor, while the level of infrastructure capital stock augments the productivity of physical capital.

$$Y = A\ \{(K_{In})^dK\}^a\ \{(K_E)^e(K_H)^f(S)^cL\}^b$$

Where: d, e, and f are the elasticity parameters of each of the capital stocks

In the case of Peru's DCGEM, there are seven Cobb–Douglas production functions corresponding to the following economic sectors:

1. agriculture and fishing
2. mining
3. manufacturing
4. electricity, gas, and water
5. construction
6. trade
7. other services

Data limitations[9] and multicollinearity among capital stocks have forced us to carry out the estimation of the Cobb–Douglas production functions in two stages. In the first stage, data for the period 1950–2011 was used to estimate the parameters of the traditional specification of

[9] GDP data for the seven economic sectors together with data on capital stocks and labor were available for the period 1950–2011; data for capital stocks for education, health, and infrastructure was available for 1971–2011 only.

the Cobb–Douglas production function ("A, "a", "b", and "c" with the customary restriction a+b=1 to guarantee constant returns to scale).

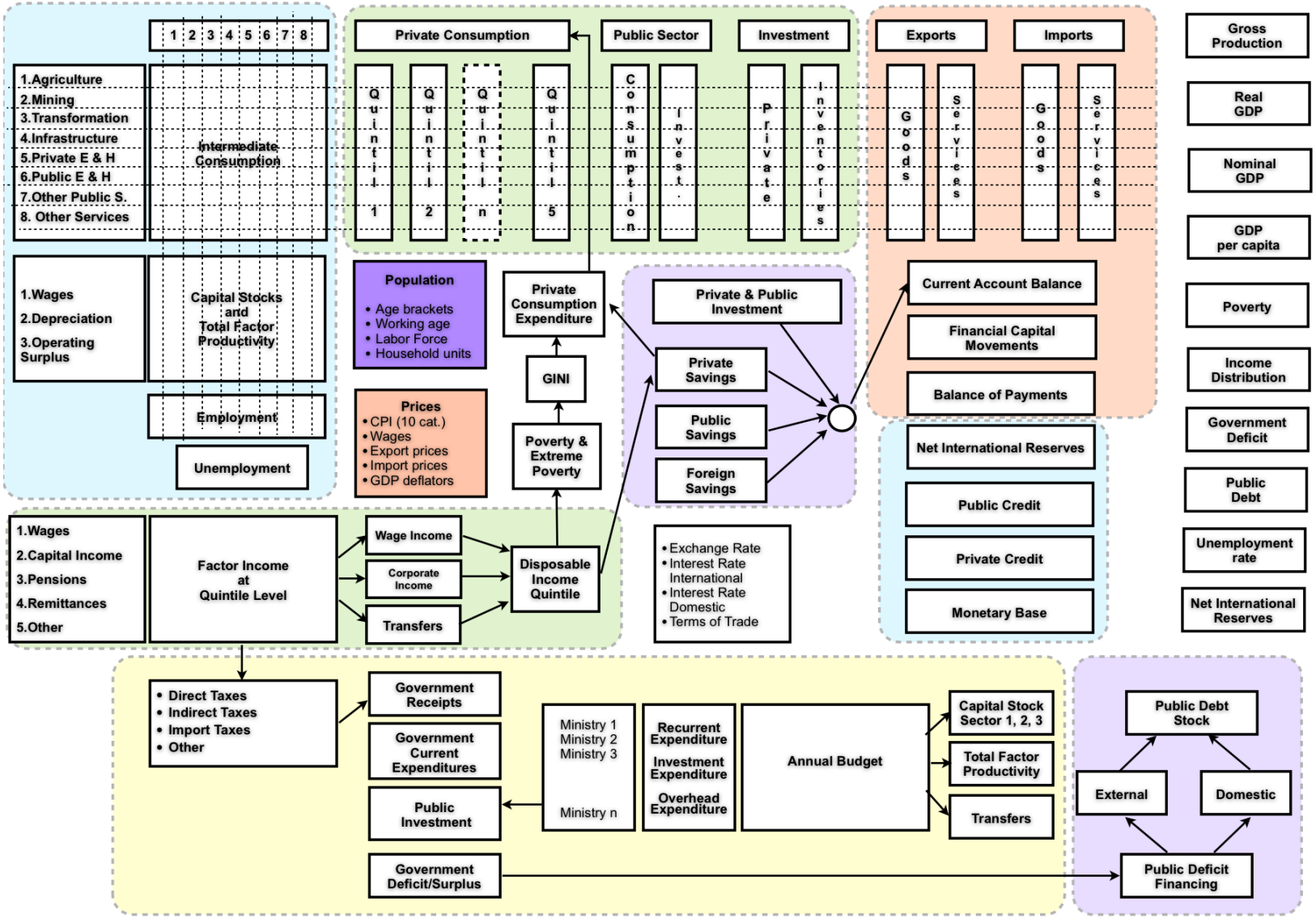
In the second stage, the parameters estimated in the first stage were fixed and used to specify each production function to estimate the remaining parameters for the education, health, and infrastructure capital stocks using available data for the period 1971–2011. For some production functions it was necessary to add the capital stocks of education and health to avoid multicollinearity and inconsistent negative signs on elasticity parameters.

The seven estimated Cobb–Douglas production functions were put together with equations describing the evolution of capital stocks and equations describing the demand for labor for each sector.[10] This system of simultaneous equations constitutes the supply block of Peru's DCGEM.

The supply block links the allocation of total private and public investment among the seven economic sectors and the evolution of sectoral real GDP. It takes as exogenous variables (coming from other blocks in the model) total private and public investment. It then uses the shares of total private investment in each economic sector as control variables. It does the same with the shares of total public investment. Different scenarios can be simulated changing the investment shares of both total private and public investment in the seven economic sectors and infrastructure, education, and health. In other words, we can simulate what would happen to GDP growth if instead of allocating 5 percent of total public investment to education and 40 percent to infrastructure, we allocate 15 percent to education and 30 percent to infrastructure. Or what would happen if we increase 10 percentage points to education spending and reduce spending by 10 percentage points in other public services. An overall logical framework of the model with the interrelations of the different components of the model is presented in Figure 12.

[10] Labor demand equations for each sector were estimated using a simple capital/labor ratio and capital utilization model.

Figure 12: Peru – Dynamic Computable General Equilibrium Model



5.3. Economic Scenarios

Assessing the impact of public and private investments on economic growth, employment, poverty, and inequality requires that economic scenarios that can be simulated with the DCGEM for Peru be defined. The macro closure of the model imposes restrictions on the type of scenarios that can be simulated. In particular, the constraint that total savings be equal to total investment forces total private investment to adjust once public investment is defined in a given scenario. In other words, in the Peruvian DCGEM, total private investment cannot be set to be exogenous. Only total private investment allocation shares among different economic sectors can be altered to define an economic scenario. Total public investment and the corresponding allocation shares among economic sectors can be set exogenously, crowding out the corresponding total private investment depending on the total savings generated by the economy.

The simulation exercise requires the definition of a baseline scenario that can be used as a benchmark to measure the impact of a given alternative scenario. For this study, the baseline scenario has been selected to be the historical values for the period 1992–2011. The reason for selecting this period is the availability of reliable data and the need to avoid the hyperinflationary period experienced by Peru prior to 1992.

The Peruvian DCGEM was calibrated to reproduce the historical official statistical figures for the simulation period. The calibration process was done by defining additive exogenous variables ("addfactors") to each behavioral equation of the model. These variables allow the intercept constant of each equation to be shifted to reproduce the historical values of each equation of the model. Addfactors were set to reproduce the exact historical values for each of the years of the simulation horizon.

The introduction of addfactors to calibrate the model does not modify the elasticity or parameters of the model equations. In fact, the dynamic properties of the model remain the same. Using addfactors to calibrate the model contributes to making the simulation results more realistic, since in this case the benchmark being used to measure the impact of removing the tax expenditures corresponds to the historical figures for all variables.

We selected five economic scenarios for our study to assess the impact of private and public investment on economic growth, employment, poverty, and income distribution. The first scenario represents a net increase of public investment at the expense of private investment (crowding out). The other four scenarios do not embody more investment !(public or private),

but a reallocation of investment among sectors. The economic scenarios used for the model simulation are the following:

Scenario 0: Baseline Scenario

Scenario 1: Increase *public* investment by 5 percent
— 2.5 percent increase in infrastructure and 2.5 percent increase in education and health combined.

	Infrastructure	Health	Education
Public	↑2.5%	↑2.5%	
Private	–	–	–

Scenario 2: Overall *public* investment unchanged, allocation changed
— 2.5 percent increase in education and in health, and 5 percent decrease in infrastructure.

	Infrastructure	Health	Education
Public	↓5%	↑2.5%	↑2.5%
Private	–	–	–

Scenario 3: Overall *private* investment unchanged, allocation changed
— 2.5 percent increase in education and in health, and 5 percent decrease in infrastructure.

	Infrastructure	Health	Education
Public	–	–	–
Private	↓5%	↑2.5%	↑2.5%

Scenario 4: Overall *public* investment unchanged, allocation changed
— 5 percent increase in infrastructure, and 2.5 percent decrease in education and in health.

	Infrastructure	Health	Education
Public	↑5%	↓2.5%	↓2.5%
Private	–	–	–

Scenario 5: Overall *private* investment unchanged, allocation changed
— 5 percent increase in infrastructure, and 2.5 percent decrease in education and in health.

	Infrastructure	Health	Education
Public	–	–	–
Private	↑5%	↓2.5%	↓2.5%

5.4. Baseline Scenario

The selected exogenous variables (private and public investment allocation) were set to their historical values. The calibration process was done estimating addfactors for each behavioral equation to reproduce the historical values of the endogenous variables. Table 1 presents the values of the selected exogenous variables for the simulation period.

Table 1. Private and Public Investment Allocation by Economic Sector 1991–2011

(percent of total private and public investment)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
PRIVATE SECTOR																					
Agriculture	2.3	2.4	6.8	10.0	7.3	9.3	24.0	9.9	5.2	5.8	4.4	3.8	7.9	10.5	9.3	8.8	9.8	8.7	6.0	7.8	7.8
Mining	10.3	10.1	11.4	10.3	4.7	9.7	20.1	1.9	30.6	28.5	7.9	7.4	9.0	7.7	8.0	8.5	10.1	9.0	8.7	8.4	8.4
Manufacture	21.4	25.1	24.8	23.1	9.6	18.6	7.9	49.9	20.7	8.9	9.7	19.9	19.3	17.9	22.8	23.9	20.3	17.2	16.8	16.6	16.6
Electricity, Gas, Water	3.1	1.5	1.7	1.6	8.6	2.5	3.2	8.7	6.3	0.5	2.5	3.1	2.5	3.1	2.2	3.7	3.3	6.7	5.7	8.2	8.2
Construction	10.1	8.6	7.1	6.4	29.6	8.3	2.1	2.3	2.6	1.9	2.1	3.5	5.5	8.4	8.0	9.7	9.7	11.5	9.1	9.3	9.3
Trade	14.8	19.4	19.9	18.3	15.8	15.5	1.2	1.4	9.7	1.3	1.2	18.3	12.1	18.5	15.3	17.7	16.2	13.6	15.7	13.1	13.1
Services	38.0	32.8	28.4	30.3	24.4	36.1	41.5	25.9	24.9	53.2	72.3	44.0	43.6	33.9	34.3	27.8	30.5	33.3	38.1	36.6	36.6
Total Private Sector	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***
Services	38.0	32.8	28.4	30.3	24.4	36.1	41.5	25.9	24.9	53.2	72.3	44.0	43.6	33.9	34.3	27.8	30.5	33.3	38.1	36.6	36.6
Transport and Telecom.	7.7	9.9	1.3	0.6	1.2	2.3	2.1	4.2	8.9	4.8	5.0	11.7	20.3	9.4	10.2	12.7	5.3	4.1	4.6	4.2	4.2
Education	4.6	17.4	11.2	8.7	7.8	8.9	9.3	7.1	6.2	7.9	13.8	8.9	6.2	5.1	4.7	5.4	5.2	4.6	7.0	6.4	6.4
Health	1.3	3.3	2.6	2.2	1.9	3.2	3.6	4.6	3.6	6.3	5.5	6.6	5.7	5.8	5.6	3.2	3.8	3.2	3.3	4.0	4.0
Other Services	24.3	2.1	13.3	18.8	13.5	21.6	26.4	9.9	6.2	34.2	47.9	16.8	11.3	13.7	13.8	6.5	16.3	21.3	23.2	21.9	21.9
PUBLIC SECTOR																					
Agriculture	54.0	44.2	33.2	23.7	19.9	18.9	18.2	24.0	25.9	26.8	21.9	21.1	18.0	15.0	13.2	15.4	17.1	13.2	11.5	9.8	8.6
Mining	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manufacture	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Electricity, Gas, Water	3.2	6.8	8.7	13.7	11.2	18.5	13.2	12.5	8.9	11.2	5.1	2.7	5.1	4.7	5.1	3.0	5.6	4.9	4.4	4.4	3.7
Construction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trade	1.2	0.5	0.5	1.3	1.2	0.3	0.6	0.3	0.5	0.5	1.4	1.4	1.4	1.8	1.8	2.2	1.8	1.9	2.1	1.6	1.1
Services	41.7	48.6	57.7	61.3	67.7	62.3	67.9	63.2	64.8	61.5	71.6	74.8	75.6	78.5	79.9	79.3	75.4	80.0	82.0	84.2	86.5
Total Public Sector	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***
Services	41.7	48.6	57.7	61.3	67.7	62.3	67.9	63.2	64.8	61.5	71.6	74.8	75.6	78.5	79.9	79.3	75.4	80.0	82.0	84.2	86.5
Transport and Telecom.	27.4	36.2	30.8	33.8	36.1	37.1	48.3	35.4	37.2	32.6	36.8	37.7	40.6	38.9	35.8	38.0	34.9	36.7	44.9	50.1	48.2
Education	8.3	4.5	9.4	13.7	16.2	11.9	10.8	12.3	14.2	14.3	16.1	16.7	16.8	17.2	20.7	17.0	12.7	17.8	17.4	17.7	17.0
Health	3.6	2.3	2.3	3.8	6.1	9.3	4.5	9.6	9.0	10.2	15.7	12.5	11.8	13.7	17.2	21.4	25.3	23.7	19.3	16.2	21.2
Other Services	2.4	5.6	15.2	10.0	9.3	4.0	4.2	5.9	4.4	4.4	2.9	7.9	6.4	8.6	6.2	3.0	2.6	1.8	0.4	0.2	0.2

Source: BCRP, INEI, and authors' calculations.

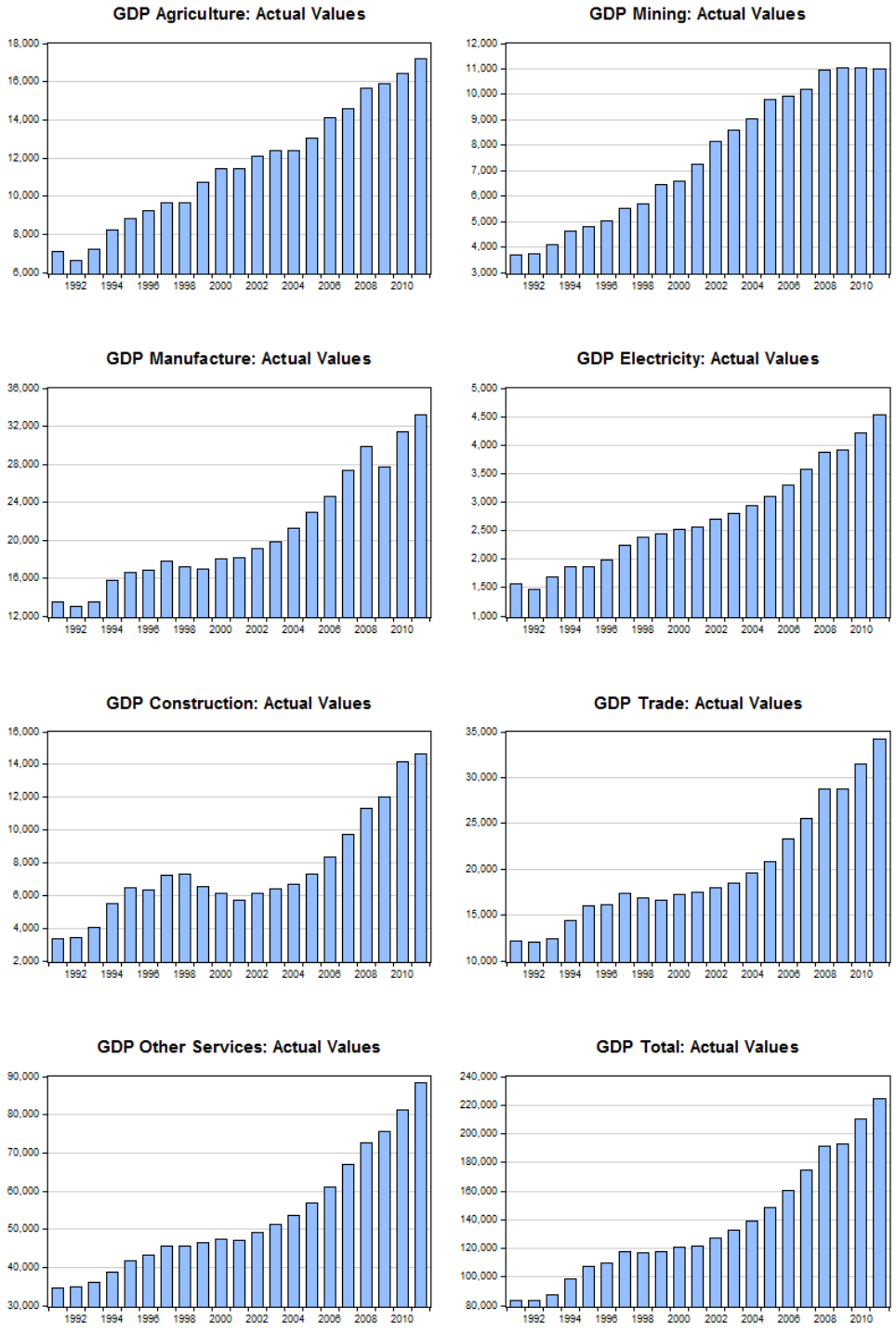
Coincidence between the actual values of the model variables and the corresponding adjusted simulated variables validate the baseline scenario as a benchmark for the simulation exercises. The results of the calibration process of the baseline scenario are presented in Table 2 and Figures 12 and 13 on the following pages. For each variable, the percent deviation of the simulated variables from the actual values is zero. These results confirm the calibration process of the model.

Table 2. Variables in the Baseline Scenario

		1991	1996	2001	2006	2011
1	Agriculture (Scenario)	7,117	9,215	11,422	14,109	17,221
	Agriculture (Baseline)	7,117	9,215	11,422	14,109	17,221
	% Deviation	-	-	-	-	-
2	Mining (Scenario)	3,699	5,045	7,263	9,926	11,000
	Mining (Baseline)	3,699	5,045	7,263	9,926	11,000
	% Deviation	-	-	-	-	-
3	Manufacture (Scenario)	13,503	16,862	18,118	24,607	33,193
	Manufacture (Baseline)	13,503	16,862	18,118	24,607	33,193
	% Deviation	-	-	-	-	-
4	Electricity (Scenario)	1,563	1,985	2,566	3,308	4,525
	Electricity (Baseline)	1,563	1,985	2,566	3,308	4,525
	% Deviation	-	-	-	-	-
5	Construction (Scenario)	3,351	6,305	5,700	8,350	14,620
	Construction (Baseline)	3,351	6,305	5,700	8,350	14,620
	% Deviation	-	-	-	-	-
6	Trade (Scenario)	12,146	16,095	17,444	23,248	34,251
	Trade (Baseline)	12,146	16,095	17,444	23,248	34,251
	% Deviation	-	-	-	-	-
7	Other Services (Scenario)	34,620	43,333	47,180	61,001	88,221
	Other Services (Baseline)	34,620	43,333	47,180	61,001	88,221
	% Deviation	-	-	-	-	-
8	Total GDP (Scenario)	83,760	109,760	121,317	160,145	224,669
	Total GDP (Baseline)	83,760	109,760	121,317	160,145	224,669
	% Deviation	-	-	-	-	-
9	Poverty (Scenario)	74.6	58.6	66.2	49.1	27.8
	Poverty (Baseline)	74.6	58.6	66.2	49.1	27.8
	Deviation % points	-	-	-	-	-
10	GINI (Scenario)	0.43	0.40	0.50	0.48	0.44
	GINI (Baseline)	0.43	0.40	0.50	0.48	0.44
	% Deviation	-	***0.00***	-	-	-
11	Inflation CPI index (Scenario)	31.3	124.0	158.0	173.9	202.3
	Inflation CPI Index (Baseline)	31.3	124.0	158.0	173.9	202.3
	% Deviation	-	-	-	-	-
12	Unemployment Rate (Scenario)	9.0	7.0	5.1	4.7	4.0
	Unemployment Rate (Baseline)	9.0	7.0	5.1	4.7	4.0
	Deviation % points	-	***0.00***	***(0.00)***	***(0.00)***	***0.00***
13	Tax Revenue GDP Ratio (Scenario)	11.2	14.0	12.3	15.2	15.5
	Tax Revenue GDP Ratio (Baseline)	11.2	14.0	12.3	15.2	15.5
	Deviation % points	-	***0.00***	***0.00***	***(0.00)***	***0.00***
14	Public Debt S/. million (Scenario)	16,666	59,037	85,245	97,502	103,271
	Public Debt S/. million (Baseline)	16,666	59,037	85,245	97,502	103,271
	% Deviation	-	***0.00***	***(0.00)***	***0.00***	***0.00***
15	Current Account US$ million (Scenario)	(1,519)	(3,658)	(1,203)	2,912	(3,341)
	Current Account US$ million (Baseline)	(1,519)	(3,658)	(1,203)	2,912	(3,341)
	Deviation US$ million	-	-	-	-	-
16	Net Int. Reserves US$ million (Scenario)	1,304	8,551	8,624	17,286	48,828
	Net Int. Reserves US$ million (Baseline)	1,304	8,551	8,624	17,286	48,828
	Deviation US$ million	-	-	-	-	-

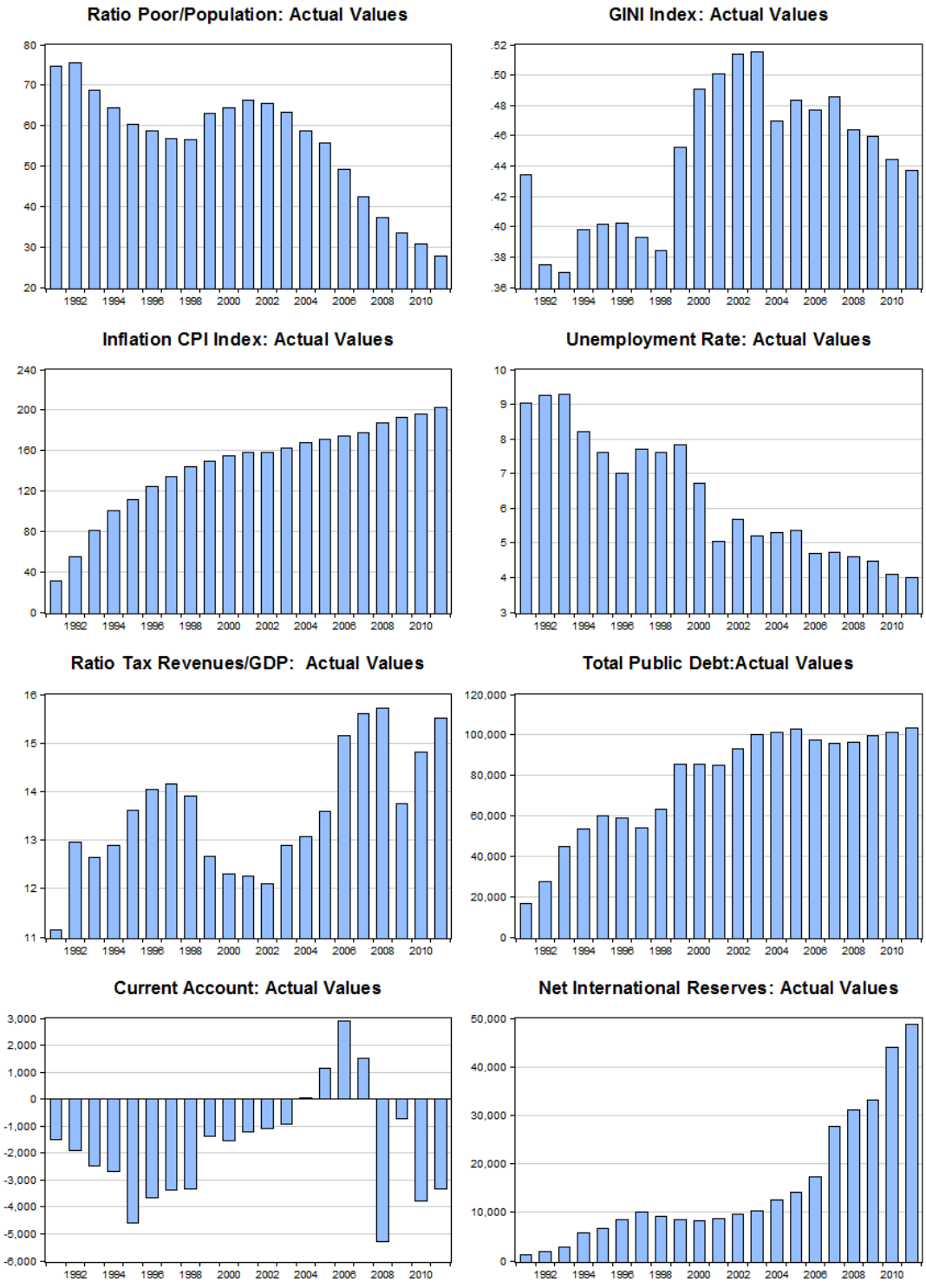
Source: Authors' calculations based on a DCGEM for Peru.

Figure 12a. Variables in the Baseline Scenario



Source: Authors' calculations based on a DCGEM for Peru.

Figure 12b. Variables in the Baseline Scenario



Source: Authors' calculations based on a DCGEM for Peru.

6. Simulation Results

In this section we present the results for each of the five economic scenarios simulated with the DCGEM. Results are presented as percent deviations from the baseline solution for each of the main variables of the DCGEM. We note that change from the historical values of the exogenous variables was limited to no more than 5 percent of the historical value to avoid non-convergence of the model due to its nonlinear structure.

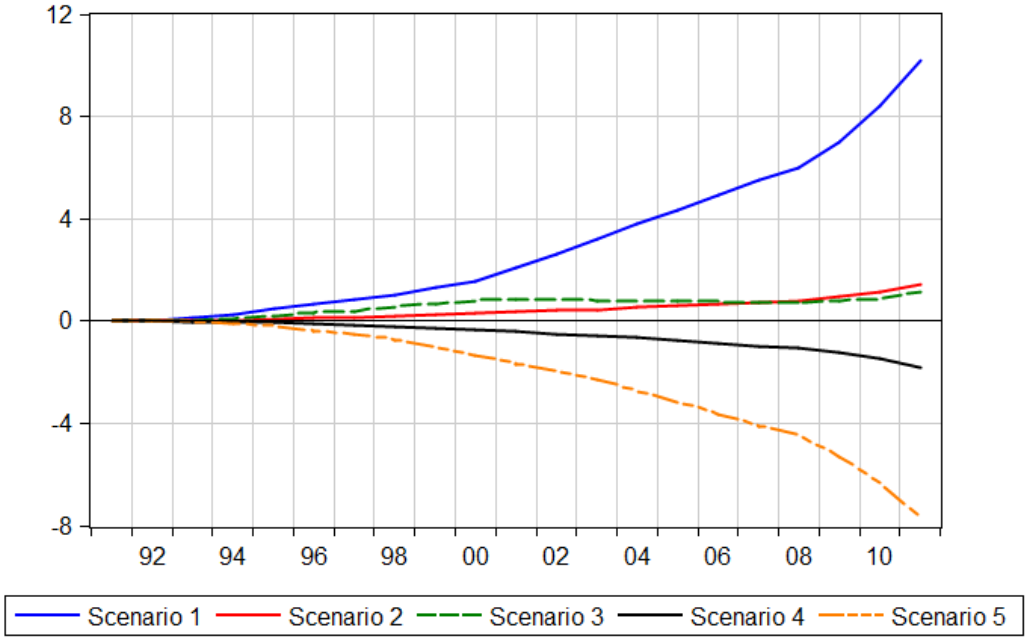
Simulation results for total GDP, unemployment, poverty, and the Gini Index are presented in this section. In Appendix 1 we present the values and graphs for other relevant variables of the model for each economic scenario. The complete set of variables can be obtained from the author.[11] Values for the selected variables are presented only for selected years of the simulation horizon. Graphs for the deviation from the baseline for each of the variables included in the analysis are presented to assess the impact of the exogenous variables through time.

6.1. Impact on Total GDP

Increasing public investment at the cost of crowding out private investment (Scenario 1) has a positive impact on total GDP. The impact of a 5 percent increase in public investment in education, health, and infrastructure on GDP is limited in the first eight years of the simulation period as a result of the crowding out effect on private investment (Figure 14). However, as GDP expands, it creates space for more private investment, which offsets the crowding out effect in the last 12 years of the simulation period.

[11] The DCGEM contains 648 endogenous variables. The complete set of results can be obtained from the author at jorge.baca@gmail.com.

Figure 14. Impact on Total GDP *(percent deviation from baseline)*



Source: Authors' calculations based on a DCGEM for Peru.

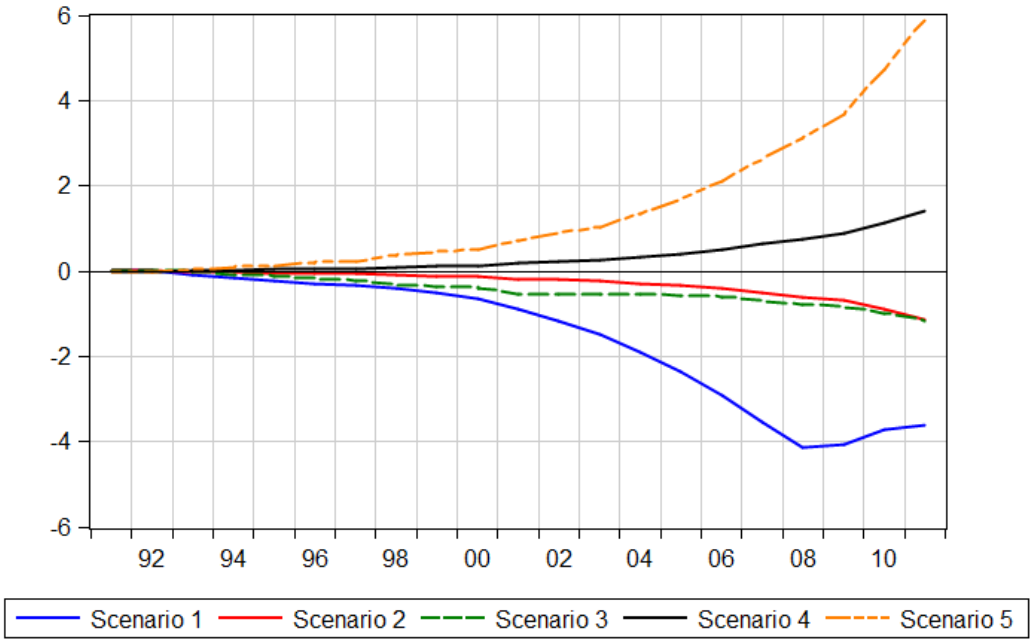
Increasing investment in education and health, at the cost of reducing investment in infrastructure (Scenarios 2 and 3), has a small but positive effect on total GDP compared with the baseline scenario. In the first 10 years of the simulation period, the impact of increasing private investment in education and health is greater than increasing public investment. However, this effect is reversed in the last 10 years of the time horizon. This could be the result of having an initial smaller capital stock in private education and health than in the public sector.

Increasing investment in infrastructure, at the cost of reducing investment in education and health (Scenarios 4 and 5), has a negative impact on total GDP when compared with the baseline scenario. However, in this case, the negative impact of private investment is higher than the impact of public investment. This result reveals the important role played by private investment in education and health, especially in the last 12 years. Lower private investment than the values observed in the past decade would have meant significantly lower rates of GDP growth. In the case of public investment in education and health, the impact would have been lower.

6.2. Impact on Unemployment

The impact on unemployment is correlated with the results on total GDP. Increasing 5 percent public investment in education, health, and infrastructure (Scenario 1) lowers unemployment but at a decreasing rate as unemployment approaches zero (Figure 15).

Figure 15. Impact on Unemployment Rate *(points deviation from baseline)*



Source: Authors' calculations based on a DCGEM for Peru.

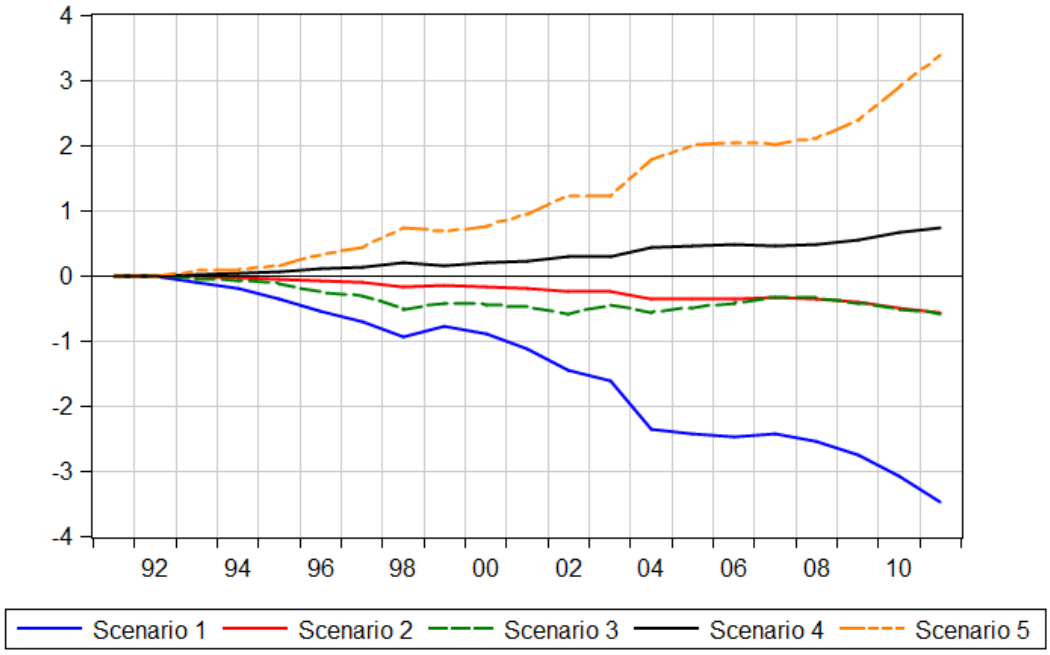
Investing more in education and health than in infrastructure (Scenarios 2 and 3) reduces unemployment in the long term. The impact of private sector investment is slightly higher than public sector investment but at a decreasing rate. At the end of the simulation period, the accumulated effect on unemployment is equal for both the public and the private sector.

Investing more in infrastructure than in education and health (Scenarios 4 and 5) has a negative impact on unemployment in the long run. The negative impact is more pronounced in the case of private investment than public investment. The impact of investing more in infrastructure than education and health is not symmetrical with the impact of investing more in education and health than in infrastructure. This asymmetry could be explained in terms of the different initial conditions for capital stocks in education and health and infrastructure. This is more relevant in the case of private investment.

6.3. Impact on Poverty

Increasing public investment in education, health, and infrastructure by 5 percent (Scenario 1) has a positive impact on reducing poor people as percentage of total population (Figure 16). However, the reduction of poverty is less accentuated in the first 12 years of the simulation period. The uneven reduction on poverty is explained by the different rates of growth of the seven economic sectors in the model. In particular, the growth rates experienced by the agricultural sector in the last eight years explain the acceleration in the reduction of poverty.

Figure 16. Impact on Poverty *(difference in points from baseline)*



Source: Authors' calculations based on a DCGEM for Peru.

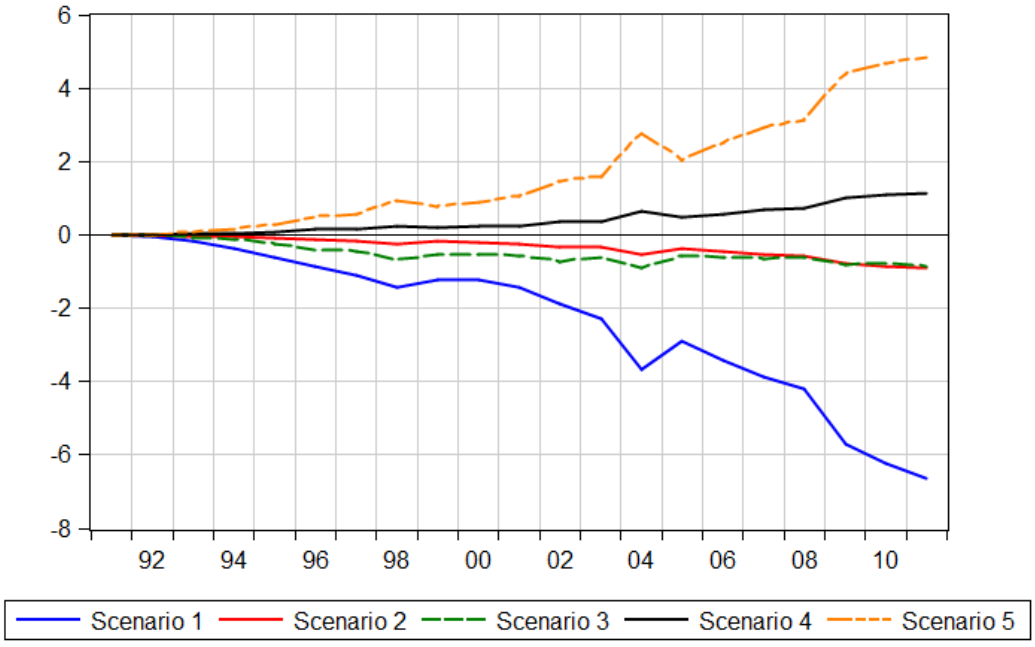
Investing more in education and health than in infrastructure (Scenarios 2 and 3) has a positive effect on reducing poverty in the long run. This impact is more pronounced in the case of private investment in the first 10 years of the time horizon under analysis. From 2004 onward, the impact of public investment in education and health is greater than the impact of private investment. As a result, the overall impact of private and public investment in education and health for the entire period is similar. These results suggest that the timing of prioritizing investment in education and health over investment in infrastructure is crucial. Simulation results indicate that the timing will depend on the initial condition of the capital stocks in infrastructure and in education and health. This applies to both the private and the public sector.

Investing more in infrastructure than in education and health (Scenarios 4 and 5) has a negative effect on reducing poverty in the long run. As in the case of poverty, the impact of investing more in infrastructure than in education and health is not symmetrical to the impact of investing more in education and health than in infrastructure. Investing less in education and health has a greater impact on poverty than investing less in infrastructure. This effect is more pronounced in the case of private investment (Scenario 5).

6.4. Impact on Income Distribution

Greater public investment in education, health, and infrastructure at the expense of less private investment (Scenario 5) has a positive effect in reducing inequality in the long run (Figure 17). The redistributive impact of public investment is greater than the impact of private investment. In particular, the impact of public investment on education and health is greater in the later years of the simulation period.

Figure 17. Impact on Gini Index *(percent deviation from baseline)*



Source: Authors' calculations based on a DCGEM for Peru.

Prioritizing education and health over infrastructure (Scenarios 2 and 3) has a slight positive impact on income distribution as measured by the Gini Index. The impact of private investment (Scenario 3) is more pronounced in the first 12 years of the simulation period, but it reverses in the last eight years of the time horizon under analysis. These results could be related

to the focus of private investment in education and health on the richer sections of the population. The impact of public investment is more consistent along the simulation period.

Prioritizing infrastructure over education and health (Scenarios 4 and 5) has a major negative impact on income distribution, particularly in the case of private investment (Scenario 5). These results explain the importance of education and health in income distribution. In Scenarios 4 and 5, more resources are invested in infrastructure but at the cost of investing in education and health. Therefore, the negative impact on income distribution is caused more by reduced investment in education and health than by the increased investment in infrastructure.

7. Conclusions

We have demonstrated that the Peruvian DCGEM, which we implemented specifically for this study, a good statistical tool to simultaneously assess the impact of public investment policies in education, health, and infrastructure on growth, unemployment, poverty, and inequality. However, the model has limitations that have to be taken into account when drawing conclusions from the simulations results. One of the shortcomings of the model is its inability to incorporate the impact of the quality and efficiency of the public expenditures.

The overarching conclusion from the simulation results is that, over the long term, prioritizing investment in education and health over investment in infrastructure generates more economic growth and reduces unemployment, poverty, and inequality. This conclusion applies to both the public and the private sector. However, the optimal mix of how much more to invest in education and health and how much less in infrastructure depends on the initial conditions of the capital stocks of education and health, and infrastructure.

For unemployment, poverty, and inequality, the impact of prioritizing investment in education and health over infrastructure is more favorable in the case of public investment than private investment because of the income brackets that public investment is focused on. Private investment focuses more on higher income bracket sectors than public investment.

The timing of prioritizing investment in education and health over infrastructure is also relevant. The initial state of capital stocks defines how the prioritizing should be done. If the state of capital stock in infrastructure is poor (as was the case in the early 1990s in Peru), then the impact of prioritizing education and health is lower. Hence, the optimal mix of public investment in education and health, and infrastructure could change over the years as a response

to the state of capital stocks in these areas. This is an indication of declining return to scale in the case of public investment in infrastructure.

Increases to the total level of public investment have to be considered with great care since they could generate severe macroeconomic imbalances, especially as seen during the early years of the simulation period. The timing of an increase in public investment should be carefully considered and should take into account the fiscal stance and the level of total public debt.

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Appendix 1. Economic Scenarios

Scenario 1: Increase public investment by 5 percent
— 2.5 percent increase in infrastructure and 2.5 percent increase in education and health combined.

In this scenario, the nominal value of total public investment increased by 5 percent in each of the years of the simulation period (1992–2011). However, this increase was concentrated in only four economic sectors: (1) electricity, gas, and water (1.25 percent); (2) transportation and communications (1.25 percent); (3) education (1.25 percent); and (4) health (1.25 percent). The other sectors were kept at their historical values. The historical allocation of private investment remained unaltered.

The accumulated impact on GDP of increasing public investment by 5 percent during the 20 years of the simulation period was 10.2 percent over historical values. However, the impact on economic growth varied across economic sectors from 6.72 percent for agriculture to 18.3 percent for electricity, gas, and water. Furthermore, the impact on growth tended to accelerate in the last years of the simulation period, reflecting the accumulated impact of stock of capital from education and health on economic growth.

Poverty, defined as the ratio of poor people to total population, reduced by 3.48 percentage points at the end of the simulation period. The reduction in poverty was accentuated in the last seven years of the simulation period, reflecting the increase in the accumulated stock of capital in health and education. The nonlinear behavior of the reduction in poverty during the simulation period reveals the impact of the growth rates of the different economic sectors on poverty, in particular the evolution of growth rates in the agriculture and trade sectors.

Inequality, measured by the Gini Index, decreased by 6.63 percent at the end of the simulation period. However, the reduction in inequality was not linear during the time period under analysis. There was a steady decline during the first five years of the simulation period (1992–98) and then there was an increase in inequality during the 1999–2003 period resulting from the historical reduction in the levels of public investment. Reduced inequality accelerated in the last four years of the simulation period, reflecting the increase in public investment. The

simulation results of this scenario reveal that there is a close correlation between public investment in education, health, and infrastructure and reduction in inequality.

Inflation, measured by the CPI index, reduced by 2.96 percent at the end of the simulation period. Most of the reduction was concentrated in the last six years of the period under analysis. The decline in inflation is explained mostly by lower public sector borrowing requirements in the last years of the simulation period as a result of improvement in the tax revenue to GDP ratio.

Unemployment decreased by 3.6 percentage points at the end of the simulation period. After a slow start due to the different growth rates for each of the economic sectors, the decline in the unemployment rate accelerated during the midyears of the simulation period and then decelerated in the later years. The deceleration is explained by the nonlinearity of the unemployment rate as it approached zero.

At the end of the simulation period, the tax revenue to GDP ratio increased by 0.31 percentage points. However, the final result came after a period of deterioration in the ratio because initially faster growth rates occurred in lower tax-generating economic sectors. In the later years of the simulation period, GDP growth rates accelerated for the more tax-generating economic sectors, allowing a reversal of the trend observed in the earlier years of the simulation exercise.

Total public debt reduced by 34 percent of its historical level at the end of the simulation period. An implicit assumption in the Dynamic Computable General Equilibrium Model (DCGEM) is that any surplus in the fiscal balance over the historical fiscal result is assigned to repaying public debt. Improvement in the tax revenue to GDP ratio in the later years of the simulation period allowed a reduction in the public debt in the corresponding years.

The current account deteriorated by US$7 billion at the end of the simulation period. The deterioration in the current account balance was the result of the implicit assumption regarding the foreign sector in the DCGEM. The model assumes that exports of goods and services remain at historical revenue levels while imports have behavioral equations linking imports of raw materials (inputs) to the performance of the different economic sectors (supply block) and imports of final goods and services to the performance of the demand side of the economy.

Net international reserves deteriorated by US$29.6 billion at the end of the simulation period. The deterioration, equivalent to more than 50 percent of the net international reserves registered in 2011, was a direct consequence of the deterioration in the current account.

However, this should be interpreted with caution because of the implicit assumption in the DCGEM that any fiscal surplus is allocated to reducing public debt. If the amount of the reduction in public debt is taken into account, the deterioration in the net international reserves is not as severe.

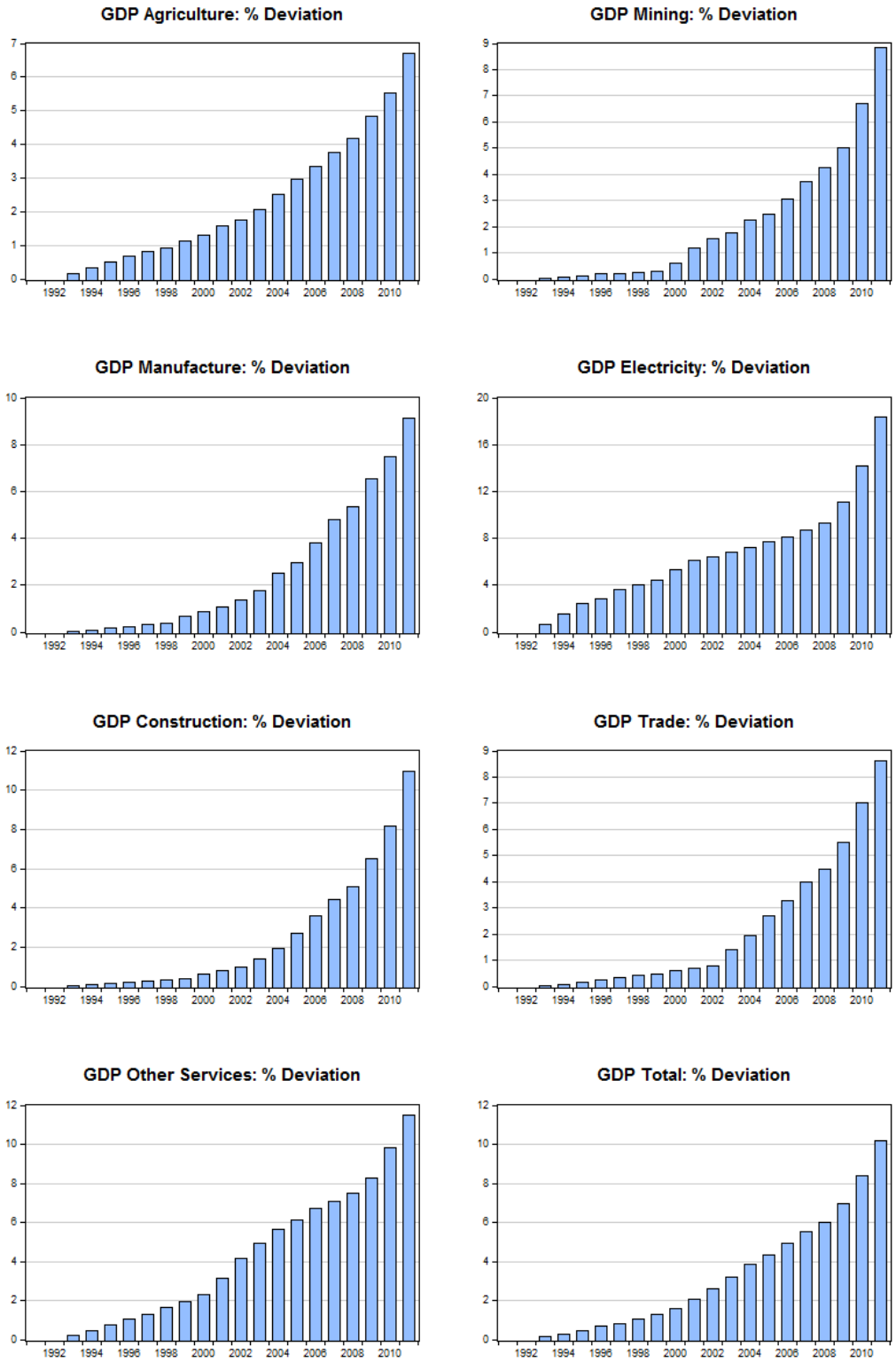
The main message from the simulation results of Scenario 1 is that a long-term increase in public investment concentrated in infrastructure and education and health translates into a long-term increase in the economic growth rate and reduced unemployment, poverty, and inequality. However, great care should be given to the size of the long-term increase since it could lead to vulnerabilities in the long-term position of international reserves.

Table A.1: Increase Public Investment by 5 Percent

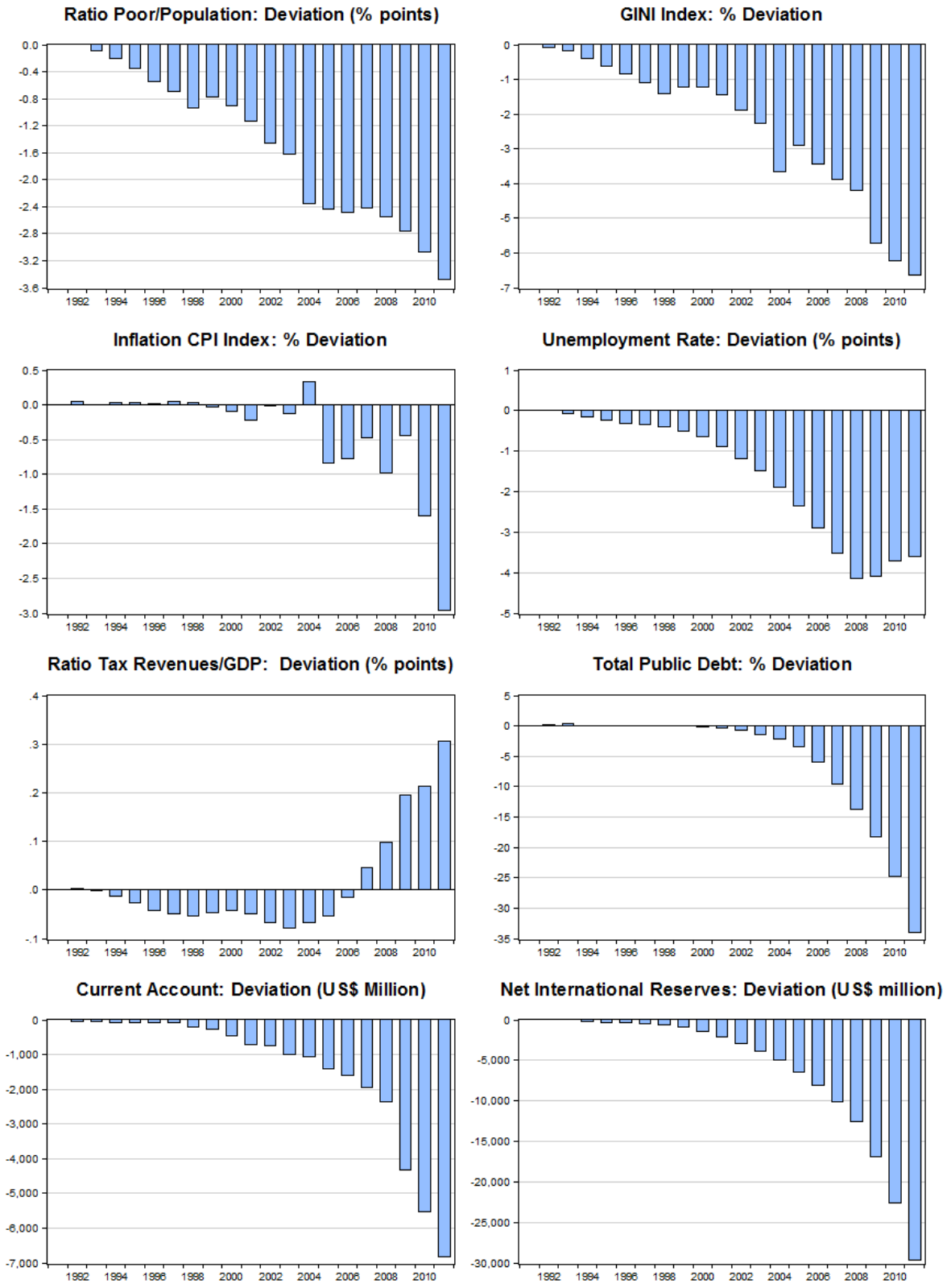
		1991	1996	2001	2006	2011
1	Agriculture (Scenario)	7,117	9,278	11,601	14,582	18,378
	Agriculture (Baseline)	7,117	9,215	11,422	14,109	17,221
	% Deviation	-	***0.68***	***1.57***	***3.35***	***6.72***
2	Mining (Scenario)	3,699	5,054	7,350	10,230	11,970
	Mining (Baseline)	3,699	5,045	7,263	9,926	11,000
	% Deviation	-	***0.18***	***1.19***	***3.06***	***8.82***
3	Manufacture (Scenario)	13,503	16,902	18,314	25,547	36,221
	Manufacture (Baseline)	13,503	16,862	18,118	24,607	33,193
	% Deviation	-	***0.24***	***1.08***	***3.82***	***9.12***
4	Electricity (Scenario)	1,563	2,042	2,723	3,576	5,354
	Electricity (Baseline)	1,563	1,985	2,566	3,308	4,525
	% Deviation	-	***2.80***	***6.10***	***8.10***	***18.30***
5	Construction (Scenario)	3,351	6,317	5,745	8,648	16,218
	Construction (Baseline)	3,351	6,305	5,700	8,350	14,620
	% Deviation	-	***0.20***	***0.80***	***3.60***	***10.90***
6	Trade (Scenario)	12,146	16,137	17,566	24,011	37,205
	Trade (Baseline)	12,146	16,095	17,444	23,248	34,251
	% Deviation	-	***0.26***	***0.70***	***3.29***	***8.63***
7	Other Services (Scenario)	34,620	43,798	48,665	65,093	98,364
	Other Services (Baseline)	34,620	43,333	47,180	61,001	88,221
	% Deviation	-	***1.10***	***3.10***	***6.70***	***11.50***
8	Total GDP (Scenario)	83,760	110,523	123,829	168,056	247,553
	Total GDP (Baseline)	83,760	109,760	121,317	160,145	224,669
	% Deviation	-	***0.70***	***2.10***	***4.90***	***10.20***
9	Poverty (Scenario)	74.6	58.0	65.1	46.6	24.3
	Poverty (Baseline)	74.6	58.6	66.2	49.1	27.8
	Deviation % points	-	***(0.55)***	***(1.13)***	***(2.48)***	***(3.48)***
10	GINI (Scenario)	0.43	0.40	0.49	0.46	0.41
	GINI (Baseline)	0.43	0.40	0.50	0.48	0.44
	% Deviation	-	***(0.85)***	***(1.43)***	***(3.43)***	***(6.63)***
11	Inflation CPI index (Scenario)	31.3	124.0	157.7	172.6	196.3
	Inflation CPI Index (Baseline)	31.3	124.0	158.0	173.9	202.3
	% Deviation	-	***0.02***	***(0.22)***	***(0.77)***	***(2.96)***
12	Unemployment Rate (Scenario)	9.0	6.7	4.2	1.8	0.4
	Unemployment Rate (Baseline)	9.0	7.0	5.1	4.7	4.0
	Deviation % points	-	***(0.31)***	***(0.88)***	***(2.90)***	***(3.61)***
13	Tax Revenue GDP Ratio (Scenario)	11.2	14.0	12.2	15.1	15.8
	Tax Revenue GDP Ratio (Baseline)	11.2	14.0	12.3	15.2	15.5
	Deviation % points	-	***(0.04)***	***(0.05)***	***(0.02)***	***0.31***
14	Public Debt S/. million (Scenario)	16,666	59,051	84,897	91,709	68,189
	Public Debt S/. million (Baseline)	16,666	59,037	85,245	97,502	103,271
	% Deviation	-	***0.02***	***(0.41)***	***(5.94)***	***(33.97)***
15	Current Account US$ million (Scenario)	(1,519)	(3,727)	(1,900)	1,324	(10,168)
	Current Account US$ million (Baseline)	(1,519)	(3,658)	(1,203)	2,912	(3,341)
	Deviation US$ million	-	***(68.5)***	***(697.6)***	***(1,588.8)***	***(6,827.0)***
16	Net Int. Reserves US$ million (Scenario)	1,304	8,194	6,512	9,204	19,171
	Net Int. Reserves US$ million (Baseline)	1,304	8,551	8,624	17,286	48,828
	Deviation US$ million	-	***(357.0)***	***(2,112.0)***	***(8,082.0)***	***(29,656.0)***

Source: Authors' calculations based on a DCGEM for Peru.

Figure A.1: Increase Public Investment by 5 Percent



Source: Authors' calculations based on a DCGEM for Peru.



Source: Authors' calculations based on a DCGEM for Peru.

Scenario 2: ***Overall* public *investment unchanged, allocation changed***
— 2.5 percent increase in education and in health, and 5 percent decrease in infrastructure.

In this scenario, the nominal value of total public investment remains unaltered from historical values. However, allocation of investment is altered to reflect a 2.5 percent increase in education and 2.5 percent in health, offset by a decrease 2.5 percent in electricity, gas, and water, and 2.5 percent in transportation and communications. The other sectors were kept at their historical values. The historical allocation of investment for the private sector remained unaltered.

The combined impact on GDP of increasing public investment in education and health and reducing investment in infrastructure during the 20 years of the simulation period was 1.42 percent over historical values. However, the impact on economic growth varied across economic sectors, from a decline of 5.17 percent for electricity, gas, and water, to an increase of 1.95 percent for other services. Furthermore, the impact on growth tended to accelerate in the last years of the simulation period, reflecting the accumulated impact of stock of capital in education and health on economic growth, in particular the trade and other services sectors.

Poverty, defined as the ratio of poor people to total population, reduced by 0.56 percentage points at the end of the simulation period. The reduction in poverty was accentuated in the last three years of the simulation period, reflecting the increase in the accumulated stock of capital in health and education. The nonlinear behavior of the reduction in poverty during the simulation period reveals the impact of the growth rates for the different economic sectors on poverty, in particular the evolution of growth rates in the agriculture and trade sectors.

Inequality, measured by the Gini Index, reduced by 0.90 percent at the end of the simulation period. However, the reduction in inequality was not linear during the time period under analysis. There was a steady decline during the first five years of the simulation period (1992–98) and then there was an increase in inequality during the 1999–2003 period resulting from the historical reduction in the levels of public investment. Reduced inequality accelerated in the last three years of the simulation period, reflecting the increase in public investment. The simulation results of this scenario reveal that there are long-term gains in reducing inequality

when public investment in education and health is prioritized over public investment in infrastructure.

Inflation, measured by the CPI index, reduced by 0.52 percent at the end of the simulation period. Most of the reduction was concentrated in the last six years of the period under analysis. The decline in inflation is explained mostly by lower public sector borrowing requirements in the last years of the simulation period as a result of improvement in the tax revenue to GDP ratio.

Unemployment decreased by 1.12 percentage points at the end of the simulation period. After a slow start due to the different growth rates for each of the economic sectors, the decline in the unemployment rate accelerated in the later years. This acceleration is explained by the accelerating growth rate in the trade and construction sectors.

The tax revenue to GDP ratio increased by 0.05 percentage points at the end of the simulation period. The slight increase in this ratio was concentrated in the last six years of the simulation period. During the first 10 years, the impact of the reduced investment in infrastructure offset the impact of increasing public investment in education and health. In the final years, the impact of investment in education and health overcame the offsetting effect of reduced investment in infrastructure. In the long term, prioritizing education and health over infrastructure generated an improvement in the tax revenue to GDP ratio.

Total public debt was reduced by 5.79 percent of its historical level at the end of the simulation period. An implicit assumption in the DCGEM is that any surplus in the fiscal balance over the historical fiscal result is assigned to repaying public debt. Improvement in the tax revenue to GDP ratio in the later years of the simulation period allowed a reduction in the public debt in the corresponding years.

The current account deteriorated by US$0.82 billion at the end of the simulation period. The deterioration in the current account balance occurred in the last three years of the simulation period. This deterioration was the result of the implicit assumption regarding the foreign sector in the DCGEM. The model assumes that exports of goods and services remain at historical revenue levels while imports have behavioral equations linking imports of raw materials (inputs) to the performance of the different economic sectors (supply block) and imports of final goods and services to the performance of the demand side of the economy.

Net international reserves deteriorated by US$2.86 billion at the end of the simulation period. The deterioration, equivalent to more than 5.8 percent of the net international

reserves registered in 2011, was a direct consequence of the deterioration in the current account. However, this should be interpreted with caution because of the implicit assumption in the DCGEM that any fiscal surplus is allocated to reducing public debt. If the amount of the reduction in public debt is taken into account, the deterioration in the net international reserves is cancelled out.

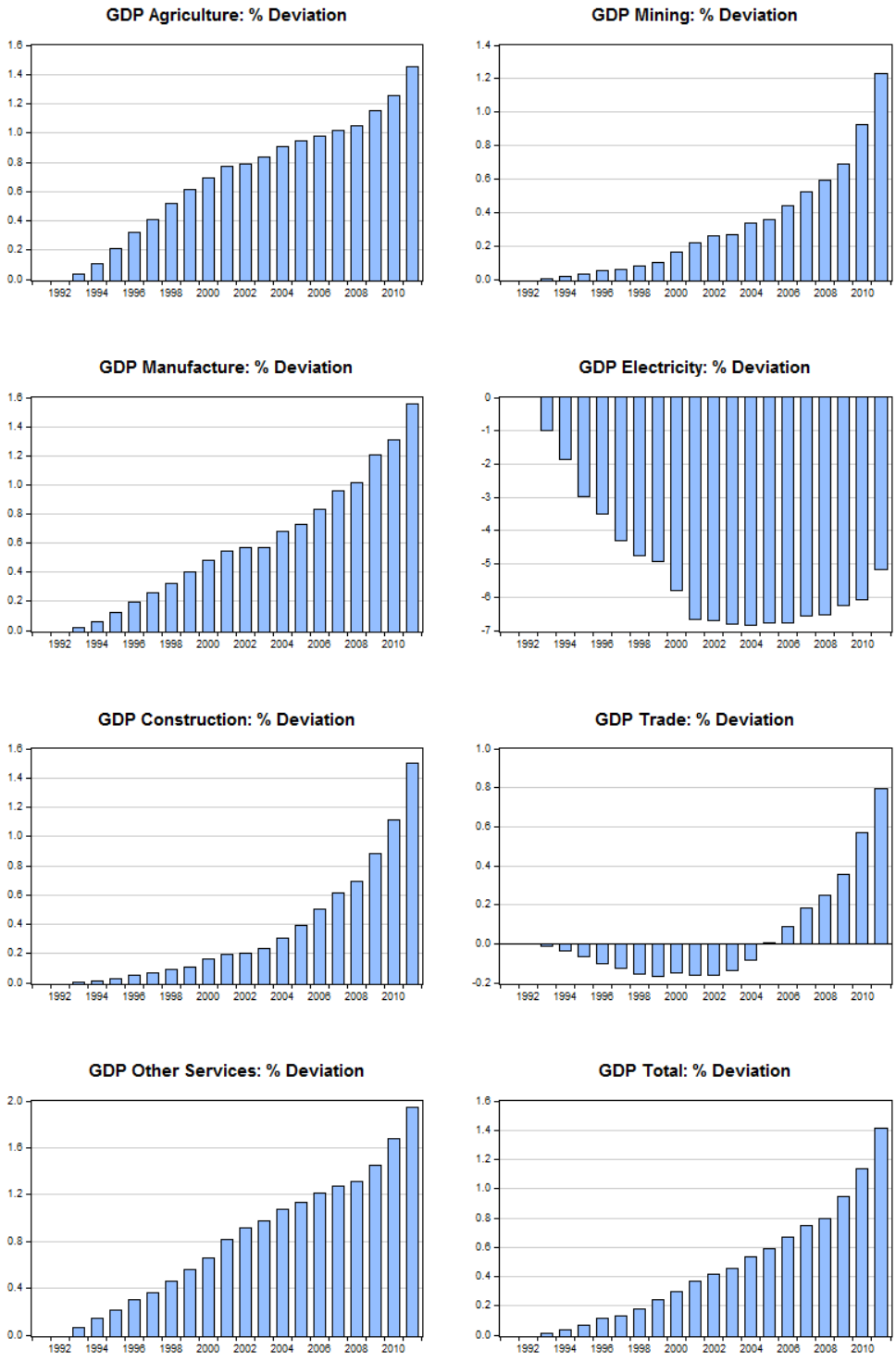
The main message from the simulation results of Scenario 2 is that a long-term increase in *public* investment in education and health accompanied by a simultaneous decrease in public investment in infrastructure translates into a moderate long-term increase in the economic growth rate and reduced unemployment, poverty, and inequality while maintaining the balance of the economy as a whole.

Figure A.2: Overall Public Investment Unchanged, Allocation Changed

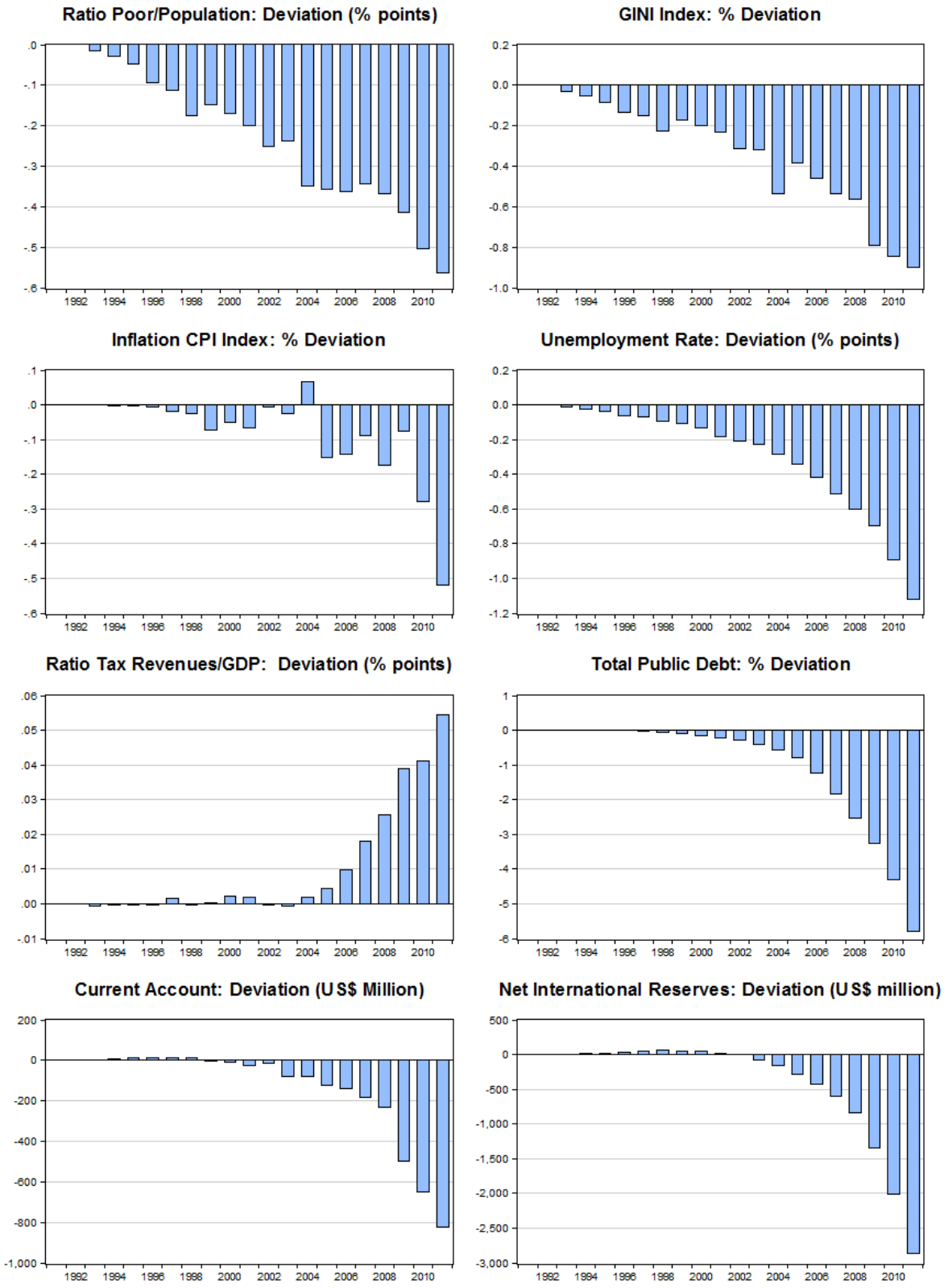
		1991	1996	2001	2006	2011
1	Agriculture (Scenario)	7,117	9,244	11,510	14,247	17,471
	Agriculture (Baseline)	7,117	9,215	11,422	14,109	17,221
	% Deviation	-	***0.32***	***0.77***	***0.98***	***1.45***
2	Mining (Scenario)	3,699	5,048	7,279	9,969	11,135
	Mining (Baseline)	3,699	5,045	7,263	9,926	11,000
	% Deviation	-	***0.05***	***0.22***	***0.44***	***1.23***
3	Manufacture (Scenario)	13,503	16,895	18,216	24,811	33,709
	Manufacture (Baseline)	13,503	16,862	18,118	24,607	33,193
	% Deviation	-	***0.19***	***0.54***	***0.83***	***1.55***
4	Electricity (Scenario)	1,563	1,916	2,395	3,083	4,291
	Electricity (Baseline)	1,563	1,985	2,566	3,308	4,525
	% Deviation	-	***(3.49)***	***(6.68)***	***(6.79)***	***(5.17)***
5	Construction (Scenario)	3,351	6,308	5,711	8,392	14,838
	Construction (Baseline)	3,351	6,305	5,700	8,350	14,620
	% Deviation	-	***0.05***	***0.20***	***0.50***	***1.50***
6	Trade (Scenario)	12,146	16,079	17,416	23,269	34,524
	Trade (Baseline)	12,146	16,095	17,444	23,248	34,251
	% Deviation	-	***(0.10)***	***(0.16)***	***0.09***	***0.80***
7	Other Services (Scenario)	34,620	43,464	47,566	61,741	89,938
	Other Services (Baseline)	34,620	43,333	47,180	61,001	88,221
	% Deviation	-	***0.30***	***0.82***	***1.21***	***1.95***
8	Total GDP (Scenario)	83,760	109,885	121,759	161,214	227,852
	Total GDP (Baseline)	83,760	109,760	121,317	160,145	224,669
	% Deviation	-	***0.11***	***0.36***	***0.67***	***1.42***
9	Poverty (Scenario)	74.6	58.5	66.0	48.7	27.2
	Poverty (Baseline)	74.6	58.6	66.2	49.1	27.8
	Deviation % points	-	***(0.09)***	***(0.20)***	***(0.36)***	***(0.56)***
10	GINI (Scenario)	0.43	0.40	0.50	0.47	0.43
	GINI (Baseline)	0.43	0.40	0.50	0.48	0.44
	% Deviation	-	***(0.13)***	***(0.23)***	***(0.46)***	***(0.90)***
11	Inflation CPI index (Scenario)	31.3	124.0	157.9	173.7	201.3
	Inflation CPI Index (Baseline)	31.3	124.0	158.0	173.9	202.3
	% Deviation	-	***(0.01)***	***(0.07)***	***(0.14)***	***(0.52)***
12	Unemployment Rate (Scenario)	9.0	6.9	4.9	4.3	2.9
	Unemployment Rate (Baseline)	9.0	7.0	5.1	4.7	4.0
	Deviation % points	-	***(0.06)***	***(0.18)***	***(0.42)***	***(1.12)***
13	Tax Revenue GDP Ratio (Scenario)	11.2	14.0	12.3	15.2	15.6
	Tax Revenue GDP Ratio (Baseline)	11.2	14.0	12.3	15.2	15.5
	Deviation % points	-	***(0.00)***	***0.00***	***0.01***	***0.05***
14	Public Debt S/. million (Scenario)	16,666	59,032	85,048	96,311	97,296
	Public Debt S/. million (Baseline)	16,666	59,037	85,245	97,502	103,271
	% Deviation	-	***(0.01)***	***(0.23)***	***(1.22)***	***(5.79)***
15	Current Account US$ million (Scenario)	(1,519)	(3,646)	(1,229)	2,773	(4,164)
	Current Account US$ million (Baseline)	(1,519)	(3,658)	(1,203)	2,912	(3,341)
	Deviation US$ million	-	***11.7***	***(26.4)***	***(139.3)***	***(822.8)***
16	Net Int. Reserves US$ million (Scenario)	1,304	8,584	8,643	16,865	45,968
	Net Int. Reserves US$ million (Baseline)	1,304	8,551	8,624	17,286	48,828
	Deviation US$ million	-	***32.8***	***18.7***	***(421.5)***	***(2,859.7)***

Source: Authors' calculations based on a DCGEM for Peru.

Figure A.2: Overall Public Investment Unchanged, Allocation Changed



Source: Authors' calculations based on a DCGEM for Peru.



Source: Authors' calculations based on a DCGEM for Peru.

Scenario 3: ***Overall* private *investment unchanged, allocation changed***
— 2.5 percent increase in education and in health, and 5 percent decrease in infrastructure

In this scenario, the nominal value of total *public* investment and its allocation among economic sectors remains unaltered. The allocation of total *private* investment is altered, reflecting an increase of 2.5 percent in education and 2.5 percent in health, offset by a decrease of 2.5 percent in electricity, gas, and water, and 2.5 percent in transportation and communications (for a total decrease of 5 percent in infrastructure). It should be pointed out that total private investment is not fixed to their historical values but is defined by the model to preserve the saving investment equilibrium condition.

The accumulated impact on GDP of increasing private investment in education and health and reducing private investment in infrastructure during the 20 years of the simulation period was an increase 1.16 percent over historical values. The impact on GDP growth is slightly lower than the impact registered with public investment in Scenario 2. The impact on economic growth varied across economic sectors, from a decline of 30.7 percent for electricity, gas, and water, to an increase of 3.23 percent for agriculture and 3.34 percent for other services. Furthermore, the impact on growth tended to accelerate in the last years of the simulation period in the construction and mining sectors, reflecting the accumulated impact of stock of capital in education and health on economic growth.

Poverty, defined as the ratio of poor people to total population, was reduced by 0.6 percentage points at the end of the simulation period. The accumulated reduction in poverty was similar to the result obtained with *public* investment in Scenario 2, but the dynamics along the simulation period are different. In the case of *public* investment, the reduction in poverty was progressive along the simulation period; in the case of *private* investment, poverty declined significantly in the early years but stagnated later. The nonlinear behavior of the reduction in poverty during the simulation period reveals the impact of growth rates for the different economic sectors on poverty, in particular the evolution of growth rates in the agriculture and trade sectors.

Inequality, measured by the Gini Index, was reduced by 0.86 percent at the end of the simulation period, slightly lower than in Scenario 2. The reduction in inequality was not linear during the time period under analysis. There was a steady decline during the first five years of the simulation period (1992–98) and then an increase in inequality during the 1999–

2003 period resulting from the historical reduction in the levels of public investment. Reduced inequality accelerated in the last four years, reflecting the increase in private investment in education and health. The simulation results of this scenario reveal that there is a close correlation between private investment in education and health, and reducing inequality.

Inflation, measured by the CPI index, was reduced by 0.49 percent at the end of the simulation period. Most of the reduction was concentrated in the last six years of the period under analysis. The decline in inflation is explained mostly by lower public sector borrowing requirements in the last years of the simulation period as a result of improvement in the tax revenue to GDP ratio.

Unemployment was reduced by 1.15 percentage points at the end of the simulation period. The accumulated decline in the unemployment rate is similar to the result obtained with *public* investment in Scenario 2, but the dynamics along the simulation period are different. In the case of *public* investment, the decline in unemployment was progressive along the simulation period; in the case of *private* investment, unemployment declined significantly in the early years, stagnated during the middle years (2000–08) and then accelerated. These differences are explained in terms of the different growth rates for the economic sectors. The acceleration in the later years is explained by the acceleration of the growth rate in GDP in the same years.

The tax revenue to GDP ratio was increased by 0.04 percentage points at the end of the simulation period, slightly less than in Scenario 2. The increase in the tax revenue to GDP ratio was concentrated in the last six years of the simulation period. The acceleration in the GDP growth rates of the more tax-generating economic sectors allowed the trend observed in the earlier years of the simulation exercise to be reversed.

Total public debt was reduced by 6.8 percent of its historical level at the end of the simulation period, slightly more than in Scenario 2. Improvement in the tax revenue to GDP ratio in the later years of the simulation period allowed public debt to be reduced in the corresponding years. An earlier increase in the ratio than in Scenario 2 (despite the end of period result being lower) explains why the reduction in the total public debt was higher in Scenario 3 than in Scenario 2.

The current account deteriorated by US$0.07 billion at the end of the simulation period, a much smaller decline than in Scenario 2. Of note, the deterioration in the current account balance occurred only at the end of the simulation exercise. During much of the period, the current account exhibited a surplus that contrasted with Scenario 2. This difference in

behavior is explained by the composition of the GDP growth rates for the economic sectors that have different import elasticity values.

Net international reserves increased by US$2.7 billion at the end of the simulation period, in clear contrast to the decrease of US$2.8 billion in Scenario 2. The improvement, which is equivalent to more than 5.5 percent of the net international reserves registered in 2011, was a direct consequence of the behavior of the current account. This result implies that promoting *private* investment in education and health offers not only less unemployment and inequality, but also greater macroeconomic stability when judged by the level of net international reserves.

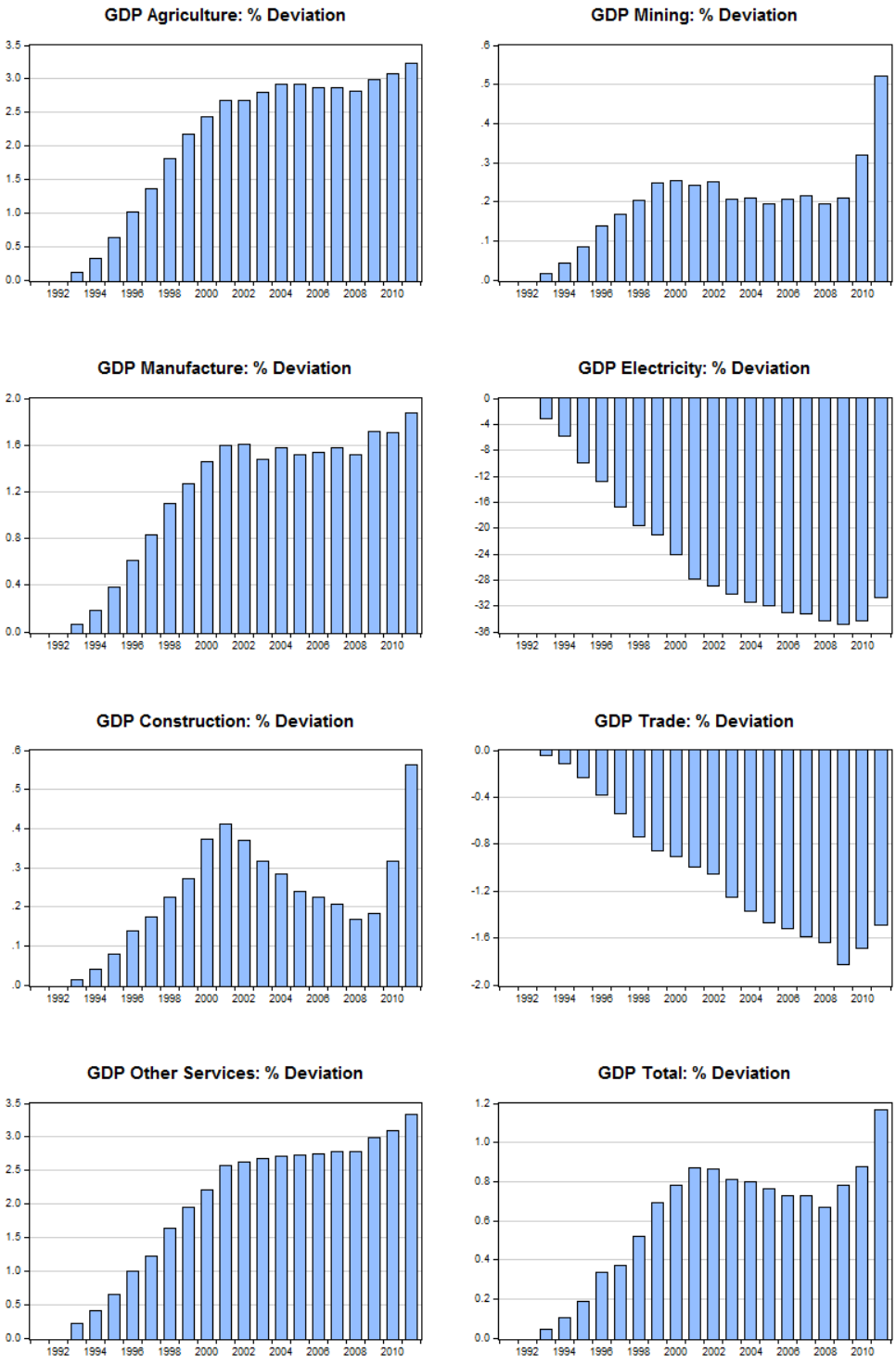
The main message from the simulation results of Scenario 3 is that a long-term increase in *private* investment in education and health, accompanied by a simultaneous reduction of private investment in infrastructure, translates into a moderate long-term increase in the economic growth rate, and reduced unemployment, poverty, and inequality while improving macroeconomic stability.

Table A.3: Overall *Private* Investment Unchanged, Allocation Changed

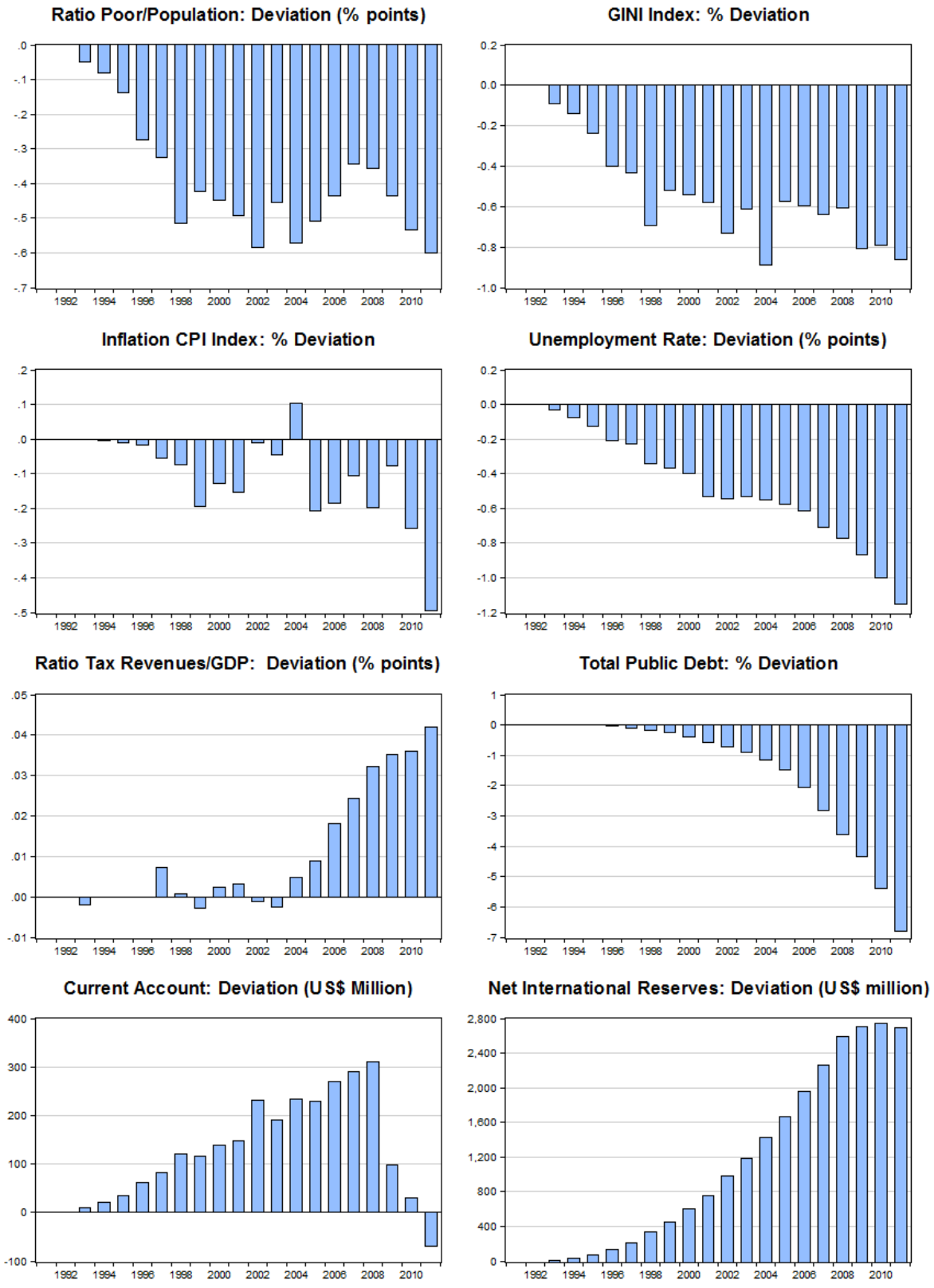
		1991	1996	2001	2006	2011
1	Agriculture (Scenario)	7,117	9,308	11,727	14,514	17,777
	Agriculture (Baseline)	7,117	9,215	11,422	14,109	17,221
	% Deviation	-	***1.02***	***2.67***	***2.87***	***3.23***
2	Mining (Scenario)	3,699	5,052	7,280	9,946	11,057
	Mining (Baseline)	3,699	5,045	7,263	9,926	11,000
	% Deviation	-	***0.14***	***0.24***	***0.21***	***0.52***
3	Manufacture (Scenario)	13,503	16,965	18,407	24,984	33,816
	Manufacture (Baseline)	13,503	16,862	18,118	24,607	33,193
	% Deviation	-	***0.61***	***1.59***	***1.53***	***1.88***
4	Electricity (Scenario)	1,563	1,731	1,849	2,214	3,135
	Electricity (Baseline)	1,563	1,985	2,566	3,308	4,525
	% Deviation	-	***(12.80)***	***(27.90)***	***(33.10)***	***(30.70)***
5	Construction (Scenario)	3,351	6,313	5,723	8,368	14,702
	Construction (Baseline)	3,351	6,305	5,700	8,350	14,620
	% Deviation	-	***0.14***	***0.41***	***0.22***	***0.56***
6	Trade (Scenario)	12,146	16,033	17,270	22,895	33,740
	Trade (Baseline)	12,146	16,095	17,444	23,248	34,251
	% Deviation	-	***(0.38)***	***(0.99)***	***(1.52)***	***(1.49)***
7	Other Services (Scenario)	34,620	43,766	48,392	62,675	91,167
	Other Services (Baseline)	34,620	43,333	47,180	61,001	88,221
	% Deviation	-	***1.00***	***2.57***	***2.74***	***3.34***
8	Total GDP (Scenario)	83,760	110,125	122,376	161,307	227,285
	Total GDP (Baseline)	83,760	109,760	121,317	160,145	224,669
	% Deviation	-	***0.33***	***0.87***	***0.73***	***1.16***
9	Poverty (Scenario)	74.6	58.3	65.7	48.7	27.2
	Poverty (Baseline)	74.6	58.6	66.2	49.1	27.8
	Deviation % points	-	***(0.27)***	***(0.49)***	***(0.44)***	***(0.60)***
10	GINI (Scenario)	0.43	0.40	0.50	0.47	0.43
	GINI (Baseline)	0.43	0.40	0.50	0.48	0.44
	% Deviation	-	***(0.40)***	***(0.58)***	***(0.60)***	***(0.86)***
11	Inflation CPI index (Scenario)	31.3	123.9	157.8	173.6	201.3
	Inflation CPI Index (Baseline)	31.3	124.0	158.0	173.9	202.3
	% Deviation	-	***(0.02)***	***(0.15)***	***(0.18)***	***(0.49)***
12	Unemployment Rate (Scenario)	9.0	6.8	4.5	4.1	2.9
	Unemployment Rate (Baseline)	9.0	7.0	5.1	4.7	4.0
	Deviation % points	-	***(0.21)***	***(0.53)***	***(0.62)***	***(1.15)***
13	Tax Revenue GDP Ratio (Scenario)	11.2	14.0	12.3	15.2	15.6
	Tax Revenue GDP Ratio (Baseline)	11.2	14.0	12.3	15.2	15.5
	Deviation % points	-	***(0.00)***	***0.00***	***0.02***	***0.04***
14	Public Debt S/. million (Scenario)	16,666	59,021	84,745	95,493	96,252
	Public Debt S/. million (Baseline)	16,666	59,037	85,245	97,502	103,271
	% Deviation	-	***(0.03)***	***(0.59)***	***(2.06)***	***(6.80)***
15	Current Account US$ million (Scenario)	(1,519)	(3,597)	(1,055)	3,183	(3,410)
	Current Account US$ million (Baseline)	(1,519)	(3,658)	(1,203)	2,912	(3,341)
	Deviation US$ million	-	***61.4***	***147.7***	***271.0***	***(69.7)***
16	Net Int. Reserves US$ million (Scenario)	1,304	8,681	9,375	19,239	51,524
	Net Int. Reserves US$ million (Baseline)	1,304	8,551	8,624	17,286	48,828
	Deviation US$ million	-	***130.1***	***750.8***	***1,952.5***	***2,696.7***

Source: Authors' calculations based on a DCGEM for Peru.

Table A.3: Overall Private Investment Unchanged, Allocation Changed



Source: Authors' calculations based on a DCGEM for Peru.



Source: Authors' calculations based on a DCGEM for Peru.

Scenario 4: ***Overall* public *investment unchanged, allocation changed***
— 5 percent increase in infrastructure, and 2.5 percent decrease in education and in health.

In this scenario, the nominal value of total *public* investment remains unaltered from historical values. However, the allocation of the investment is altered, reflecting an increase of 2.5 percent in electricity, gas, and water, and 2.5 percent in transportation and communications (for a total 5 percent in infrastructure), offset by a decrease in investment of 2.5 percent in education and in health. Investment in other sectors was kept at historical values. The historical allocation of private investment remained unaltered.

The combined impact on GDP of increasing public investment in infrastructure and reducing public investment in education and health during the 20 years of the simulation period was a decline of 1.83 percent over historical values. However, the negative impact on economic growth varied across economic sectors, from a decline of 2.36 percent for other services to an increase of 4.52 percent for electricity, gas, and water. Furthermore, the negative impact on growth tended to accelerate in the last years of the simulation period, reflecting the accumulated impact of lower stock of capital in Education And Health on economic growth, in particular agriculture, trade, and other services.

Poverty, defined as the ratio of poor people to total population, increased by 0.74 percentage points at the end of the simulation period. The increase in poverty was accentuated in the last three years of the simulation period, reflecting the decrease in the accumulated stock of capital in health and education. The nonlinear behavior of the reduction in poverty during the simulation period reveals the impact of growth rates for the different economic sectors on poverty, in particular the evolution of growth rates in the agriculture and construction sectors.

Inequality, measured by the Gini Index, increased by 1.15 percent at the end of the simulation period. However, the increase in inequality was not linear during the time period under analysis. There was a small increase during the first five years of the simulation period (1992–98) and then an acceleration of the deterioration of inequality during the rest of the simulation period, resulting from the historical reduction in the levels of public investment in education and health. The increase of inequality accelerated in the last three years of the

simulation period, reflecting the relatively low stock of capital in education and health. The simulation results of this scenario reveal that there is a long-term increase in inequality when public investment in infrastructure is prioritized over public investment in education and health.

Inflation, measured by the CPI index, increased by 0.69 percent at the end of the simulation period. Most of the reduction was concentrated in the last six years of the period under analysis. The increase of inflation is explained mostly by increased public sector borrowing requirements in the last years of the simulation period as a result of the deterioration in the tax revenue to GDP ratio.

Unemployment increased by 1.43 percentage points at the end of the simulation period. After a slow increase in the first years of the simulation period due to the different growth rates of the economic sectors, the increase in unemployment rate accelerated in the later years. The acceleration during the later years is explained by the deceleration in the growth rate of total GDP.

The tax revenue to GDP ratio decreased by 0.07 percentage points at the end of the simulation period. The slight decline in the tax revenue to GDP ratio was concentrated in the last six years of the simulation period. During the first 10 years, the impact of reduced investment in education and health was offset by the impact of increasing public investment in infrastructure. In the final years, the impact of lower investment in education and health overcame the positive effect of increasing investment in infrastructure. In the long term, prioritizing infrastructure over education and health causes deterioration in the tax revenue to GDP ratio.

Total public debt was increased by 7.33 percent of its historical level at the end of the simulation period. Deterioration of the tax revenue to GDP ratio in the later years of the simulation period generated the increase in public debt in the corresponding years. This effect was compounded by higher inflation.

The current account improved by US$1.1 billion at the end of the simulation period. The improvement in the current account balance occurred in the last three years of the period. This improvement was the result of the implicit assumption regarding the foreign sector in the DCGEM. The model assumes that exports of goods and services remain at historical revenue levels while imports have behavioral equations linking imports of raw materials (inputs) to the performance of the different economic sectors (supply block) and imports of final goods and services to the performance of the demand side of the economy. The negative impact on GDP

growth generated less demand for imports, resulting in an improvement in the current account in the later years of the simulation period.

Net international reserves increased by US$4.1 billion at the end of the simulation period. The improvement, which is equivalent to more than 8.4 percent of the net international reserves registered in 2011, was a direct consequence of the improvement in the current account. However, this should be interpreted with caution because of the deterioration in total public debt. If the amount of the increase in public debt is taken into account, the improvement in the net international reserves is cancelled out.

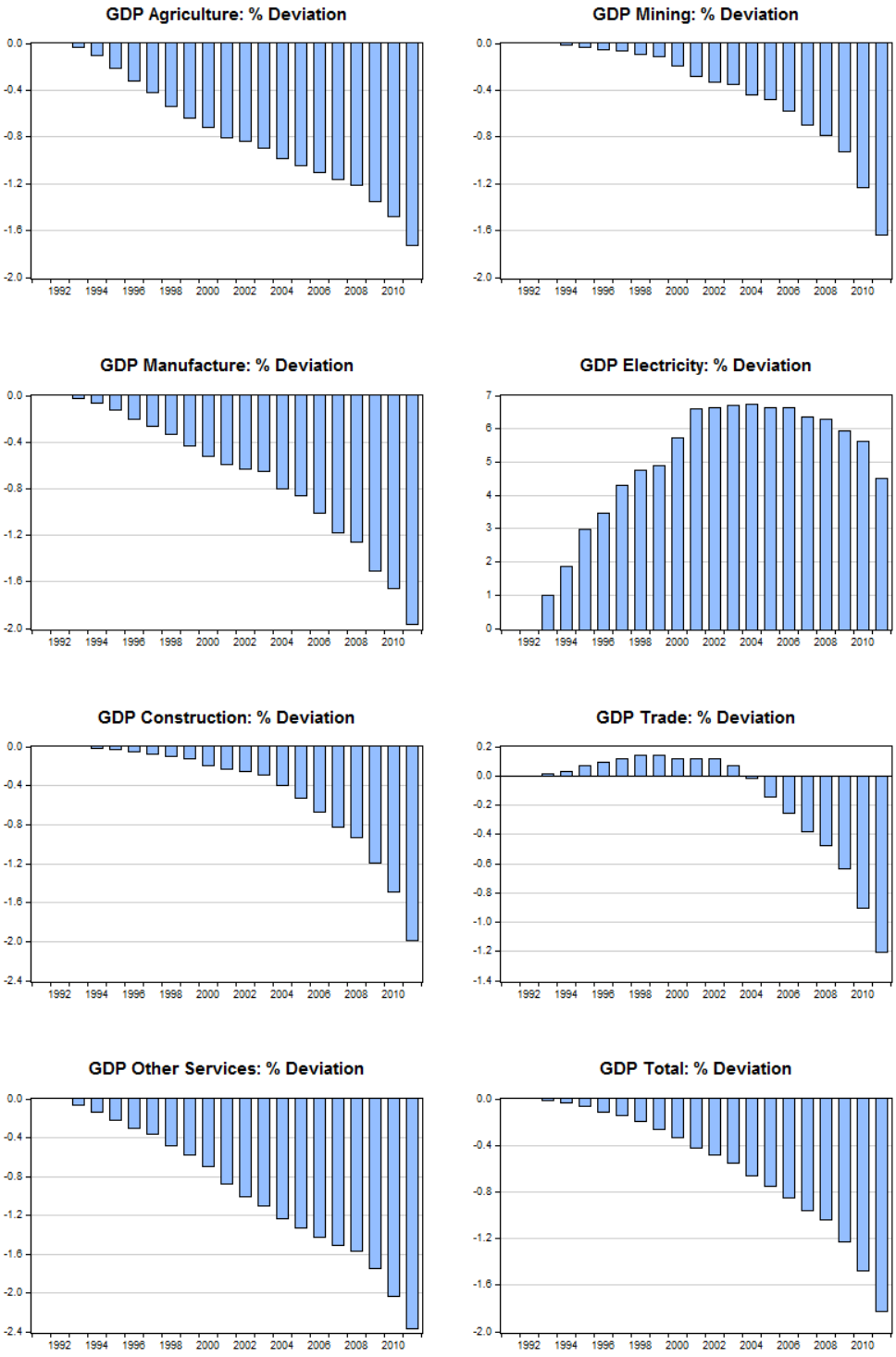
The main message from the simulation results of Scenario 4 is that a long-term increase of *public* investment in infrastructure accompanied by a simultaneous decrease in *public* investment in education and health translates into a moderate long-term decline in the economic growth rate and a corresponding increase in unemployment, poverty, and inequality while maintaining the balance of the economy as a whole.

Table A.4: Overall Public Investment Unchanged, Allocation Changed

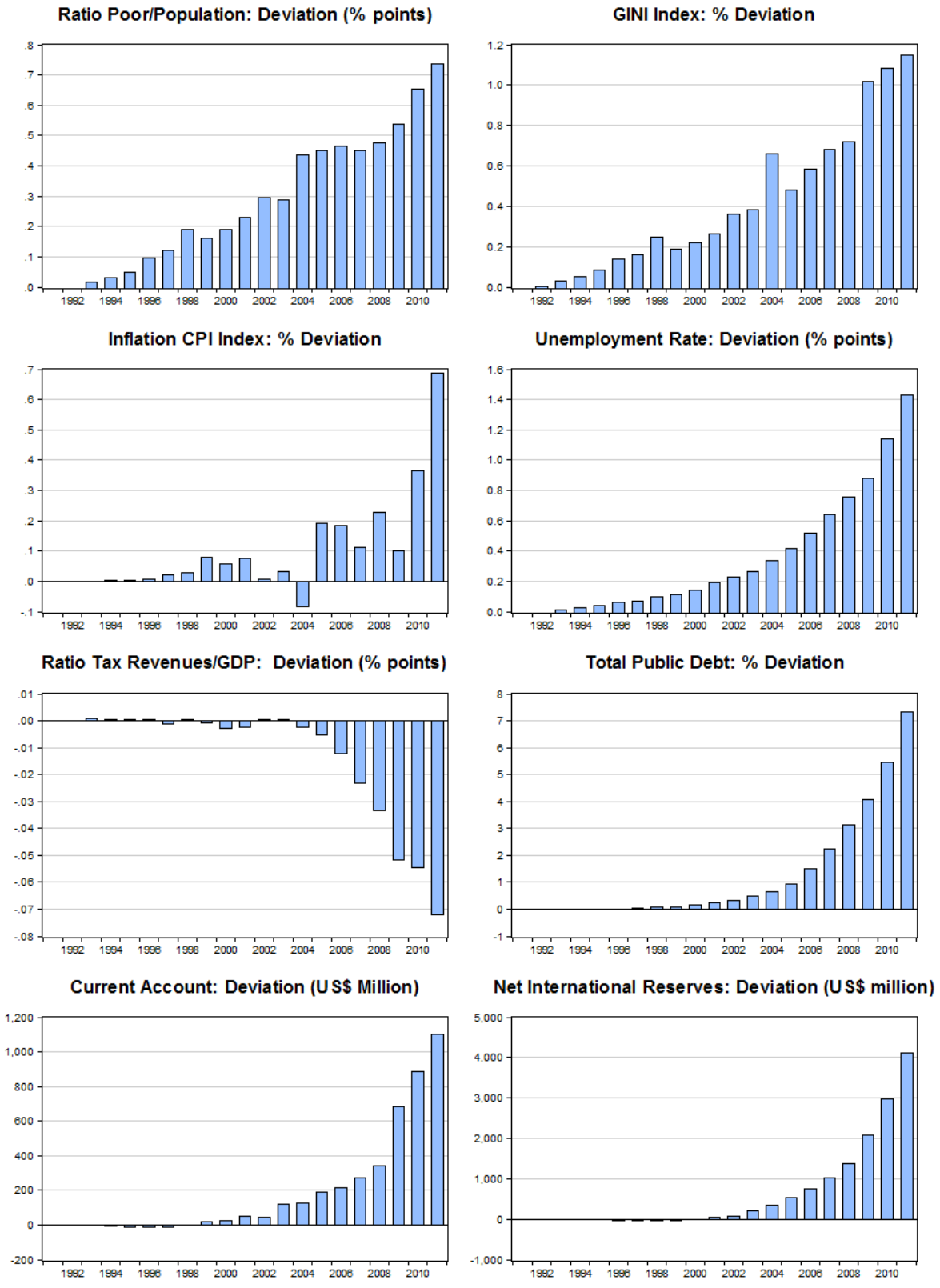
		1991	1996	2001	2006	2011
1	Agriculture (Scenario)	7,117	9,185	11,329	13,954	16,924
	Agriculture (Baseline)	7,117	9,215	11,422	14,109	17,221
	% Deviation	-	***(0.32)***	***(0.81)***	***(1.10)***	***(1.72)***
2	Mining (Scenario)	3,699	5,043	7,242	9,868	10,820
	Mining (Baseline)	3,699	5,045	7,263	9,926	11,000
	% Deviation	-	***(0.05)***	***(0.28)***	***(0.58)***	***(1.63)***
3	Manufacture (Scenario)	13,503	16,828	18,010	24,358	32,541
	Manufacture (Baseline)	13,503	16,862	18,118	24,607	33,193
	% Deviation	-	***(0.20)***	***(0.60)***	***(1.01)***	***(1.96)***
4	Electricity (Scenario)	1,563	2,055	2,736	3,526	4,729
	Electricity (Baseline)	1,563	1,985	2,566	3,308	4,525
	% Deviation	-	***3.48***	***6.61***	***6.62***	***4.52***
5	Construction (Scenario)	3,351	6,301	5,686	8,293	14,328
	Construction (Baseline)	3,351	6,305	5,700	8,350	14,620
	% Deviation	-	***(0.05)***	***(0.24)***	***(0.67)***	***(1.99)***
6	Trade (Scenario)	12,146	16,111	17,465	23,189	33,839
	Trade (Baseline)	12,146	16,095	17,444	23,248	34,251
	% Deviation	-	***0.10***	***0.12***	***(0.25)***	***(1.20)***
7	Other Services (Scenario)	34,620	43,201	46,765	60,129	86,135
	Other Services (Baseline)	34,620	43,333	47,180	61,001	88,221
	% Deviation	-	***(0.31)***	***(0.88)***	***(1.43)***	***(2.36)***
8	Total GDP (Scenario)	83,760	109,629	120,809	158,782	220,560
	Total GDP (Baseline)	83,760	109,760	121,317	160,145	224,669
	% Deviation	-	***(0.12)***	***(0.42)***	***(0.85)***	***(1.83)***
9	Poverty (Scenario)	74.6	58.7	66.4	49.6	28.5
	Poverty (Baseline)	74.6	58.6	66.2	49.1	27.8
	Deviation % points	-	***0.10***	***0.23***	***0.47***	***0.74***
10	GINI (Scenario)	0.43	0.40	0.50	0.48	0.44
	GINI (Baseline)	0.43	0.40	0.50	0.48	0.44
	% Deviation	-	***0.14***	***0.26***	***0.58***	***1.15***
11	Inflation CPI index (Scenario)	31.3	124.0	158.1	174.3	203.7
	Inflation CPI Index (Baseline)	31.3	124.0	158.0	173.9	202.3
	% Deviation	-	***0.01***	***0.08***	***0.18***	***0.69***
12	Unemployment Rate (Scenario)	9.0	7.1	5.3	5.2	5.4
	Unemployment Rate (Baseline)	9.0	7.0	5.1	4.7	4.0
	Deviation % points	-	***0.06***	***0.19***	***0.52***	***1.43***
13	Tax Revenue GDP Ratio (Scenario)	11.2	14.0	12.3	15.1	15.4
	Tax Revenue GDP Ratio (Baseline)	11.2	14.0	12.3	15.2	15.5
	Deviation % points	-	***0.00***	***(0.00)***	***(0.01)***	***(0.07)***
14	Public Debt S/. million (Scenario)	16,666	59,043	85,469	98,955	110,841
	Public Debt S/. million (Baseline)	16,666	59,037	85,245	97,502	103,271
	% Deviation	-	***0.01***	***0.26***	***1.49***	***7.33***
15	Current Account US$ million (Scenario)	(1,519)	(3,668)	(1,153)	3,125	(2,239)
	Current Account US$ million (Baseline)	(1,519)	(3,658)	(1,203)	2,912	(3,341)
	Deviation US$ million	-	***(10.3)***	***49.4***	***212.6***	***1,101.5***
16	Net Int. Reserves US$ million (Scenario)	1,304	8,520	8,666	18,033	52,933
	Net Int. Reserves US$ million (Baseline)	1,304	8,551	8,624	17,286	48,828
	Deviation US$ million	-	***(31.2)***	***41.9***	***747.0***	***4,105.0***

Source: Authors' calculations based on a DCGEM for Peru.

Table A.4: Overall Public Investment Unchanged, Allocation Changed



Source: Authors' calculations based on a DCGEM for Peru.



Source: Authors' calculations based on a DCGEM for Peru.

Scenario 5: ***Overall* private *investment unchanged, allocation unchanged***
— 5 percent increase in infrastructure, and 2.5 percent decrease in education and in health.

In this scenario, the nominal value of total *public* investment and its allocation among economic sectors remains unaltered. The allocation of total *private* investment is altered, with an increase of 2.5 percentage points in electricity, gas, and water, and 2.5 percentage points in transportation and communications (for a total increase of 5 percentage points in infrastructure), offset by a decrease of 2.5 percentage points in education and 2.5 percentage points in health. It should be pointed out that total private investment is not fixed to their historical values but is defined by the model to preserve the saving investment equilibrium condition.

The combined impact on GDP of increasing private investment in infrastructure and reducing private investment in education and health during the 20 years of the simulation period was a reduction of 7.73 percentage points over historical values. However, the negative impact on economic growth varies across economic sectors, from a decline of 9.8 percentage points for other services to an increase of 16.4 percentage points for electricity, gas, and water. Furthermore, the negative impact on growth tended to accelerate in the last years of the simulation period, reflecting the accumulated impact of lower stock of capital in education and health on economic growth, in particular agriculture, trade, and other services.

Poverty, defined as the ratio of poor people to total population, increased by 3.38 percentage points at the end of the simulation period. The increase in poverty was accentuated in the last three years of the simulation period, reflecting the decrease in the accumulated stock of capital in health and education. The nonlinear behavior of the increase in poverty during the simulation period reveals the impact of growth rates for the different economic sectors on poverty, in particular the evolution of growth rates in the agriculture and construction sectors.

Inequality, measured by the Gini Index, increased by 4.86 percent at the end of the simulation period. However, the increase in inequality was not linear during the time period under analysis. There was a small increase during the first five years of the simulation period (1992–98) and then an acceleration of the deterioration in inequality during the rest of the

simulation period resulting from the historical reduction in the levels of *public* investment in education and health. The increase in inequality accelerated in the last three years of the simulation period, reflecting the relative low levels of stock of capital in education and health. The simulation results of this scenario reveal that there is a long-term increase in inequality when private investment in infrastructure is prioritized over private investment in education and health.

Inflation, measured by the CPI index, increased by 3.07 percent at the end of the simulation period. Most of the increase was concentrated in the last six years of the period under analysis. The increase in inflation is explained mostly by the increase in public sector borrowing requirements in the last years of the simulation period as a result of the deterioration in the tax revenue in GDP ratio.

Unemployment increased by 5.88 percentage points at the end of the simulation period. After a slow increase in the first years of the period due to the different growth rates of the economic sectors, the increase in unemployment rate accelerated in the later years. The acceleration in the later years is explained by the deceleration in the growth rate of total GDP.

The tax revenue to GDP ratio decreased by 0.31 percentage points at the end of the simulation period. The decline in the tax revenue to GDP ratio was concentrated in the last six years of the simulation period. During the first 10 years, the impact of reduced investment in education and health offsets the impact of increasing private investment in infrastructure. In the final years, the impact of lower investment in education and health overcame the positive effect of increasing investment in infrastructure. In the long term, prioritizing infrastructure over education and health causes deterioration in the tax revenue to GDP ratio.

Total public debt was increased by 31 percent of its historical level at the end of the simulation period. Deterioration of the tax revenue to GDP ratio in the later years of the simulation period generated the increase in public debt in the corresponding years. This effect was compounded by higher inflation.

The current account improved by US$4.6 billion at the end of the simulation period. The improvement in the current account balance occurred in the last three years of the period. This improvement was the result of the implicit assumption regarding the foreign sector in the DCGEM. The model assumes that exports of goods and services remain at historical revenue levels while imports have behavioral equations linking imports of raw materials (inputs) to the performance of the different economic sectors (supply block) and imports of final goods and services to the performance of the demand side of the economy. The negative impact on GDP

growth generated less demand for imports, resulting in an improvement in the current account in the later years of the simulation period.

Net international reserves increased by US$17.2 billion at the end of the simulation period. The improvement, which is equivalent to more than 35.3 percent of the net international reserves registered in 2011, was a direct consequence of the improvement of the current account. However, this should be interpreted with caution because of the deterioration in total public debt. If the amount of the increase in public debt is taken into account, the improvement in the net international reserves is partially cancelled out.

The main message from the simulation results of Scenario 5 is that a long-term increase in *private* investment in infrastructure accompanied by a simultaneous decrease in private investment in education and health translates into a long-term decline in the economic growth rate and a corresponding increase in unemployment, poverty, and inequality while maintaining the balance of the economy as a whole.

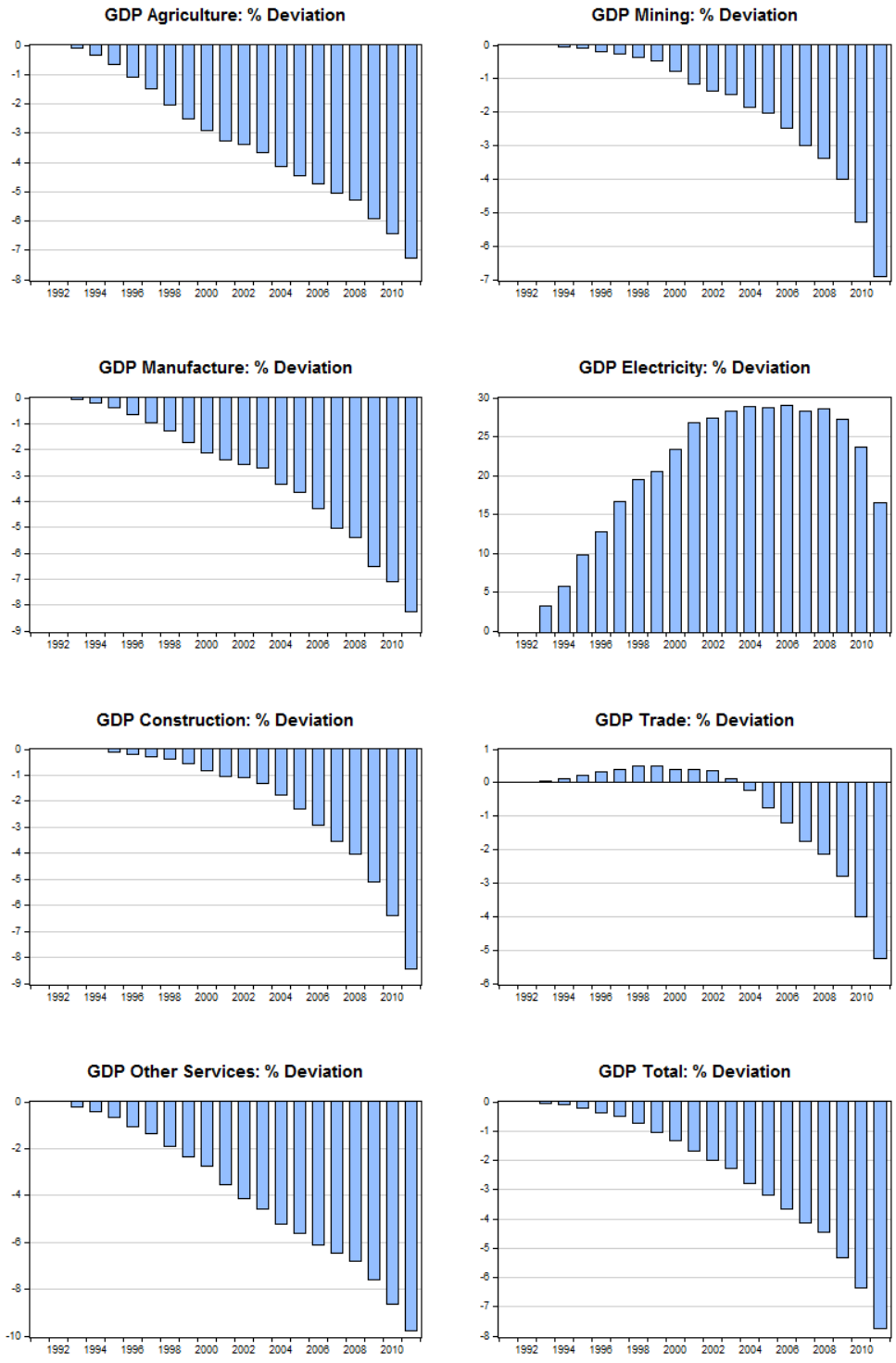
When comparing the simulation results from Scenario 4 (public sector) with results of Scenario 5 (private sector), it is important to point out that the impact of Scenario 5 on growth, unemployment, poverty, and inequality are more accentuated than Scenario 4. The reason for these results is the difference in size of the private investment sector compared with the public investment sector. This impact is compounded by the saving investment closing condition (crowding out effect) of the DCGEM, which adjusts total private investment to maintain the equilibrium of total savings equal total investment.

Table A.5: Overall Private Investment Unchanged, Allocation Changed

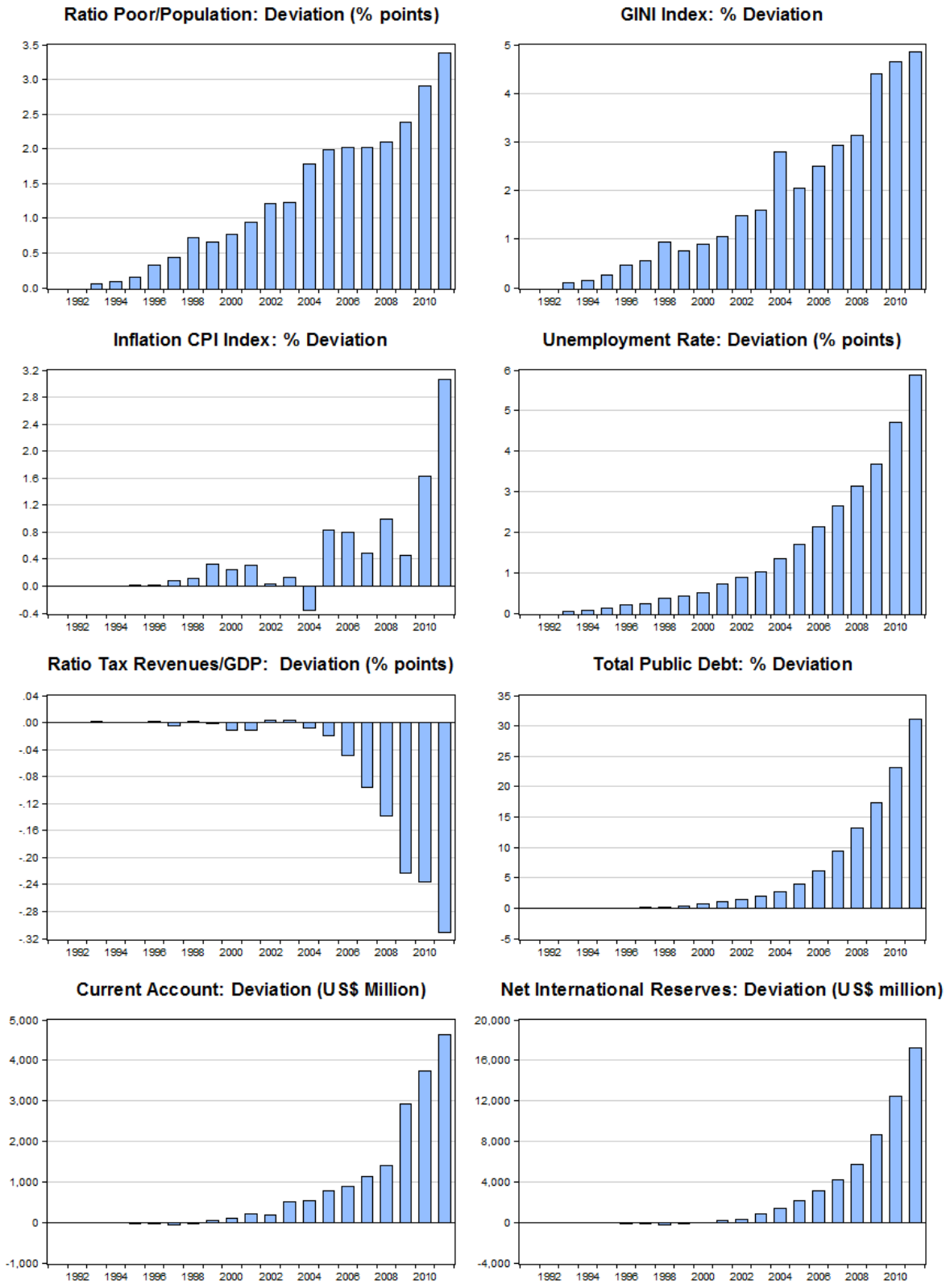
		1991	1996	2001	2006	2011
1	Agriculture (Scenario)	7,117	9,116	11,048	13,442	15,969
	Agriculture (Baseline)	7,117	9,215	11,422	14,109	17,221
	% Deviation	-	***(1.07)***	***(3.27)***	***(4.73)***	***(7.27)***
2	Mining (Scenario)	3,699	5,036	7,180	9,679	10,238
	Mining (Baseline)	3,699	5,045	7,263	9,926	11,000
	% Deviation	-	***(0.18)***	***(1.14)***	***(2.49)***	***(6.92)***
3	Manufacture (Scenario)	13,503	16,750	17,683	23,549	30,455
	Manufacture (Baseline)	13,503	16,862	18,118	24,607	33,193
	% Deviation	-	***(0.66)***	***(2.40)***	***(4.30)***	***(8.25)***
4	Electricity (Scenario)	1,563	2,239	3,255	4,269	5,268
	Electricity (Baseline)	1,563	1,985	2,566	3,308	4,525
	% Deviation	-	***12.80***	***26.80***	***29.10***	***16.40***
5	Construction (Scenario)	3,351	6,293	5,641	8,105	13,385
	Construction (Baseline)	3,351	6,305	5,700	8,350	14,620
	% Deviation	-	***(0.18)***	***(1.03)***	***(2.93)***	***(8.44)***
6	Trade (Scenario)	12,146	16,145	17,511	22,965	32,453
	Trade (Baseline)	12,146	16,095	17,444	23,248	34,251
	% Deviation	-	***0.31***	***0.38***	***(1.22)***	***(5.25)***
7	Other Services (Scenario)	34,620	42,871	45,517	57,265	79,575
	Other Services (Baseline)	34,620	43,333	47,180	61,001	88,221
	% Deviation	-	***(1.07)***	***(3.52)***	***(6.12)***	***(9.80)***
8	Total GDP (Scenario)	83,760	109,327	119,262	154,303	207,310
	Total GDP (Baseline)	83,760	109,760	121,317	160,145	224,669
	% Deviation	-	***(0.39)***	***(1.69)***	***(3.65)***	***(7.73)***
9	Poverty (Scenario)	74.6	58.9	67.1	51.1	31.2
	Poverty (Baseline)	74.6	58.6	66.2	49.1	27.8
	Deviation % points	-	***0.32***	***0.94***	***2.03***	***3.38***
10	GINI (Scenario)	0.43	0.40	0.51	0.49	0.46
	GINI (Baseline)	0.43	0.40	0.50	0.48	0.44
	% Deviation	-	***0.47***	***1.05***	***2.50***	***4.86***
11	Inflation CPI index (Scenario)	31.3	124.0	158.5	175.3	208.6
	Inflation CPI Index (Baseline)	31.3	124.0	158.0	173.9	202.3
	% Deviation	-	***0.02***	***0.32***	***0.79***	***3.07***
12	Unemployment Rate (Scenario)	9.0	7.2	5.8	6.8	9.9
	Unemployment Rate (Baseline)	9.0	7.0	5.1	4.7	4.0
	Deviation % points	-	***0.21***	***0.73***	***2.12***	***5.88***
13	Tax Revenue GDP Ratio (Scenario)	11.2	14.0	12.2	15.1	15.2
	Tax Revenue GDP Ratio (Baseline)	11.2	14.0	12.3	15.2	15.5
	Deviation % points	-	***0.00***	***(0.01)***	***(0.05)***	***(0.31)***
14	Public Debt S/. million (Scenario)	16,666	59,057	86,132	103,556	135,344
	Public Debt S/. million (Baseline)	16,666	59,037	85,245	97,502	103,271
	% Deviation	-	***0.03***	***1.04***	***6.21***	***31.06***
15	Current Account US$ million (Scenario)	(1,519)	(3,704)	(998)	3,795	1,296
	Current Account US$ million (Baseline)	(1,519)	(3,658)	(1,203)	2,912	(3,341)
	Deviation US$ million	-	***(45.4)***	***204.5***	***882.2***	***4,637.1***
16	Net Int. Reserves US$ million (Scenario)	1,304	8,438	8,772	20,373	66,076
	Net Int. Reserves US$ million (Baseline)	1,304	8,551	8,624	17,286	48,828
	Deviation US$ million	-	***(113.0)***	***148.0***	***3,086.0***	***17,249.0***

Source: Authors' calculations based on a DCGEM for Peru.

Table A.5: Overall Private Investment Unchanged, Allocation Changed



Source: Authors' calculations based on a DCGEM for Peru.



Source: Authors' calculations based on a DCGEM for Peru.

Appendix II. Dynamic Computable General Equilibrium Model (DCGEM) for Peru

DCGEMs are a class of economic models that allow economists to systematically analyze the most important policy challenges and economic shocks on an inter-temporal basis. Their structure is similar to that of Computable General Equilibrium Models (CGEM), with the added feature of being dynamic to allow the impact analysis of a given policy or shock over a number of years. This feature is especially important when analyzing policies that are introduced over a given period of years.

The Peruvian DCGEM is an economy-wide model because it describes the behavior of producers and consumers and the linkages between them. Producers are depicted by seven Cobb–Douglas production functions (agriculture and fishing; mining; manufacturing; electricity, gas, and water; construction; trade; and other services) and consumers by a 10 consumption categories Linear Expenditure System (LES). The income generated by factors of production (capital and labor) and other sources of income (remittances from abroad, transfers, and other sources of income) is discriminated by income distribution categories (quintiles). This structure allows the analysis of policy impact on poverty levels and income distribution, as well sectorial economic growth and unemployment.

The main dynamic elements of the model are the annual level of investment in each sector together with population growth and sectoral employment. Sectoral investment is discriminated in public and private investment. The closure of the model is done through the equilibrium between savings and investment and equilibrium between each sectoral production function and its corresponding sectoral demand. In the latter case, equilibrium is guaranteed by the capital utilization factor embodied on each Cobb–Douglas production function.

To conduct experiments with the DCGEM, the analyst first elaborates a base scenario of Peru's economy based on recent performance (calibration of the model). Then the analyst defines alternative policy scenarios and measures the differences between the alternative scenarios and the base scenario to draw conclusions about the impact of the proposed policies on economic growth, poverty levels, income distribution, tax revenue, etc. Hence, the model is not a forecasting model but instead a model that allows the analyst to study the impact of alternative policy scenarios on a given economic path (the base scenario).

The model has been implemented in Eviews 7 and consists of 10 blocks: population, production, income, consumption, prices, external sector, fiscal sector, public debt, monetary sector, and equilibrium block.

Macro data (statistical information) for the period 1980–2011 was obtained from different government sources and allowed us to implement the DCGEM for Peru. The *Instituto Nacional de Estadistica* (INEI) and the Central Bank (BCRP) were our main sources.

The model encompasses 10 blocks that interact to generate equilibrium solutions on a yearly basis. The DCGEM was the main analytical tool used to assess the impact of alternative policies on economic growth, unemployment, poverty, and income distribution. The structure and logical framework of each of the 10 blocks of the model is briefly described in the following paragraphs.

The **Population Block** describes population dynamics grouped by age brackets (0–4 years, 5–9 years, 10—14, and so on up to 80 to + years) to model evolution of the working age population, the labor force, and total population depending on net survival rates by age bracket, net fertility rates, and expenditures on health.

The **Production Block** comprises three Cobb–Douglas production functions corresponding to each of the seven sectors of Peru's economy. For each production function, capital stocks and labor employed have been estimated to obtain capital-output and capital-labor ratios. Data for the period 1980–2011 was used to estimate each production function. Factor elasticity for capital and labor, and total factor productivity was estimated and analyzed for each economic sector. This block determines employment levels for each of the seven sectors and the economy-wide unemployment level.

The **Consumption Block** comprises five Linear Expenditure System (LES) consumption functions estimated to correspond with each of the quintiles included in the model. Income elasticity for each quintile and price elasticity for each of the 10 categories of consumption reported in the Household Expenditure Survey were estimated for the period 1989–2010. This block allowed us to measure the impact of changes to relative prices (changes of indirect tax rates) and income (changes on direct tax rates) on income distribution.

The **Income Block** describes the income distribution among the quintiles of each of the types of income considered in the model (wages for each sector, operating surplus for each sector, pensions, remittances, and other income). Income distribution for each quintile was obtained from the expenditure distribution of the Household Expenditure Survey, with a savings

estimate added for each quintile. These values were reconciled with the values for each category of income to obtain data consistency between the expenditure side in the National Accounts (consumption) and the national income side. This block is crucial in studying the impact of removing preferential tax treatments on poverty and income distribution.

The **Prices Block** comprises price indices for each of the 10 categories of consumption, for each of the seven GDP deflators, deflators for investment, exports, and imports. This component also describes the exchange rate, average wage for each sector, and interest rates. The price indices of the 10 categories of consumption are explained in terms of international price indices (US price index), exchange rate, and domestic public sector borrowing requirements (public sector credit). The nominal exchange rate is adjusted to maintain purchasing power parity. Average wages and interest rates are exogenous to the model. GDP deflators are weighting averages of the 10 consumption categories of price indices and adjustment factors to preserve equilibrium conditions between nominal supply and demand.

The **Fiscal Sector Block** describes each of the government receipts by tax type and the main items of government expenditures to explain the financing gaps (surplus/deficit) and the nature of financing requirements (domestic/external debt). It also encompasses the fiscal expenditures by ministry to discriminate the allocation of public capital expenditures to the three different economic sectors of the model. It also takes into account expenditures on education and health that link improvements in the Total Factor Productivity parameter of the three Cobb–Douglas production functions and on the net survival rates of each of the age brackets of the population component of the model.

The **External Block** covers both exports and imports of goods and services and the main items of the balance of payments. Exports and imports of goods and services are modeled on current and constant terms to link with the demand side of GDP. The exchange rate and terms of trade play an important role in the dynamics of this component. The exports component is basically exogenous to the model. The import component is modeled as a reaction function to the GDP levels of the different economic sectors.

The **Monetary Block** comprises the net international reserves linked to the Balance of Payments BOP block, the public and private credit aggregates and other items of total liquidity, including the Monetary Base, M1, M2 and M3.

The **Debt Block** links with the *fiscal sector block* to describe the debt dynamics, both external and domestic, and including amortization, interest payments, and new loans. It allowed us to estimate the debt/GDP ratio and its impact on risk levels.

The **Equilibrium Block** encompasses three different equilibrium conditions that guarantee a consistent closure of the model, making possible the conditions of a general equilibrium model. The first condition is the equilibrium between total investment and savings. This condition guarantees that the level of total investment is equal to the three different sources of savings, namely external, fiscal, and private savings. The second equilibrium condition is the equilibrium between the real GDP on the production side and the real GDP on the demand side. This equilibrium is realized at the level of each of the economic sectors contemplated in the model. The equilibrium is guaranteed by the capital utilization factor in each of the seven Cobb–Douglas production functions. The third equilibrium condition is the equilibrium between nominal GDP on the production side and nominal GDP on the demand side. This equilibrium is realized by adjusting the price deflators of the seven economic sectors of the model.

In the next pages we present some econometric results of the main equations of the model (production functions). A complete specification of the model with its database, equations, estimation procedures, scenarios results, and graph procedures in Eviews 7 format can be obtained from the author (jorge.baca@gmail.com).

First Stage Estimation of Production Functions (Cobb–Douglas with constant returns to scale)

log(GDP) = A + a1 log(K) + (1 – a1) log (L) + (1 – a1) (a2) log(LITERACY)

EQ10GDPAGRIC	Dep. Var:	LOG(SU001AGRIC)		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SU010KAGRI(-1)	0.744419	0.141432	5.263423	0.0000
SU021LITERACY	0.317540	0.440285	0.721214	0.4737
A	−1.450310	0.369337	−3.926797	0.0002
EQ11GDPMINING	Dep. Var:	LOG(SU002MINING)		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SU011KMINI(-1)	0.787836	0.037197	21.180035	0.0000
SU021LITERACY	0.305283	0.596885	0.511460	0.6110
A	−0.876771	0.465112	−1.885074	0.0644
EQ12GDPMANUF	Dep. Var:	LOG(SU003MANUF)		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SU012KMANU(-1)	0.333340	0.090475	3.684347	0.0005
SU021LITERACY	−0.995882	0.204282	−4.875046	0.0000
A	4.308156	0.644981	6.679507	0.0000
EQ13GDPELECT	Dep. Var:	LOG(SU004ELECT)		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SU013KELEC(-1)	0.755284	0.092916	8.128686	0.0000
SU021LITERACY	−2.244302	1.256509	−1.786141	0.0793
A	2.328015	0.706762	3.293917	0.0017
EQ14GDPCONSTR	Dep. Var:	LOG(SU005CONSTR)		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SU014KCONS(-1)	0.668615	0.048872	13.681011	0.0000
SU021LITERACY	−0.364377	0.384547	−0.947549	0.3473
A	0.516702	0.397756	1.299042	0.1991
EQ15GDPTRADE	Dep. Var:	LOG(SU006TRADE)		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SU015KTRAD(-1)	0.885849	0.106593	8.310556	0.0000
SU021LITERACY	−5.189214	3.753981	−1.382323	0.1722
A	1.754286	1.136435	1.543675	0.1281
EQ16GDPOTHER	Dep. Var:	LOG(SU007OTHRSERV)		
Variable	Coefficient	Std. Error	t-Statistic	Prob.
SU016KOTHE(-1)	0.745302	0.180661	4.125405	0.0001
SU021LITERACY	−2.907031	1.244803	−2.335334	0.0230
A	3.057138	1.793748	1.704330	0.0937

Second Stage Production Functions Estimation. Elasticity parameters "*d*", "*e*", and "*f*" were estimated by a grid search method using the log likelihood statistic as maximizing objective function. Other parameters (except "A") were kept fixed to the values obtained in the first stage estimation.

Inclusion of infrastructure (electricity gas and water, and transportation) and education and health as augmenting factors.

$$Y = A\ \{(K_{In})^d K_f\}^a\ \{(K_E)^e (K_H)^f (S)^c L_f\}^b$$

Dependent Variable: LOG(SU001AGRIC)
Sample (adjusted): 1973 2011
Included observations: 39 after adjustments
LOG(SU001AGRIC)=0.7392*LOG(SU010KAGRI(-1))+0.7392*0.68
*LOG(@MOVAV((SU013KELEC(-1)+SU053KTRANS(-1))
/SU017KTOT(-1),3))+(1-0.7392)*LOG(SU025LAGRIC)+(0.7392)
*0.09*LOG(SU021LITERACY)+(0.7392)*0.15
*LOG(@MOVAV((SU054KEDUC(-1)+SU055KHEALTH(-1))
/POTOT(-1),3))+C(7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(7)	0.585539	0.020994	27.89045	0.0000
R-squared	0.865545	Mean dependent var		9.063992
Adjusted R-squared	0.865545	S.D. dependent var		0.357556
S.E. of regression	0.131109	Akaike info criterion		-1.200267
Sum squared resid	0.653205	Schwarz criterion		-1.157612
Log likelihood	24.40521	Hannan-Quinn criter.		-1.184963
Durbin-Watson stat	0.137019			

Dependent Variable: LOG(SU002MINING)
Sample (adjusted): 1973 2011
Included observations: 39 after adjustments
LOG(SU002MINING)=0.7878*LOG(SU011KMINI(-1))+0.7878*0.25
*LOG(@MOVAV((SU013KELEC(-1) +SU053KTRANS(-1))
/SU017KTOT(-1),3))+(1-0.7878)*LOG(SU026LMINING)+(1-0.7878)
*0.35*LOG(SU021LITERACY)+(1-0.7878)*0.18
*LOG(@MOVAV((SU054KEDUC(-1) +SU055KHEALTH(-1))
/POTOT(-1),3))+C(7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(7)	-0.200082	0.026398	-7.579442	0.0000
R-squared	0.892478	Mean dependent var		8.512933
Adjusted R-squared	0.892478	S.D. dependent var		0.502752
S.E. of regression	0.164855	Akaike info criterion		-0.742194
Sum squared resid	1.032733	Schwarz criterion		-0.699538
Log likelihood	15.47278	Hannan-Quinn criter.		-0.726889
Durbin-Watson stat	0.137149			

Dependent Variable: LOG(SU003MANUF)
Sample (adjusted): 1973 2011
Included observations: 39 after adjustments
LOG(SU003MANUF)=0.3333*LOG(SU012KMANU(-1))+0.3333*0.18
*LOG(@MOVAV((SU013KELEC(-1)+SU053KTRANS(-1)) ,3))+(1
-0.3333)*LOG(SU027LMANUF)+(1-0.3333)*0.45*LOG(SU021LITER
ACY)+(1-0.3333)*0.17*LOG(@MOVAV((SU054KEDUC(-1)
+SU055KHEALTH(-1))/POTOT(-1),3))+C(7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(7)	0.275222	0.040875	6.733209	0.0000
R-squared	0.073646	Mean dependent var		9.760525
Adjusted R-squared	0.073646	S.D. dependent var		0.265219
S.E. of regression	0.255266	Akaike info criterion		0.132289
Sum squared resid	2.476116	Schwarz criterion		0.174944
Log likelihood	-1.579630	Hannan-Quinn criter.		0.147593
Durbin-Watson stat	0.099159			

Dependent Variable: LOG(SU004ELECT)
Sample (adjusted): 1973 2011
Included observations: 39 after adjustments
LOG(SU004ELECT)=0.7553*LOG(SU013KELEC(-1))+0.7553*0.48
*LOG(@MOVAV(SU053KTRANS(-1)/SU017KTOT(-1),3))+(1
-0.7553)*LOG(SU028LELECT)+(1-0.7553)*0.35*LOG(SU021LITER
ACY)+(1-0.7553)*0.18*LOG(@MOVAV((SU054KEDUC(-1)
+SU055KHEALTH(-1))/POTOT(-1),3))+C(7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(7)	0.834746	0.039058	21.37169	0.0000
R-squared	0.768436	Mean dependent var		7.491192
Adjusted R-squared	0.768436	S.D. dependent var		0.506888
S.E. of regression	0.243920	Akaike info criterion		0.041354
Sum squared resid	2.260886	Schwarz criterion		0.084010
Log likelihood	0.193592	Hannan-Quinn criter.		0.056659
Durbin-Watson stat	0.179924			

Dependent Variable: LOG(SU005CONSTR)
Method: Least Squares
Date: 03/12/13 Time: 13:03
Sample (adjusted): 1973 2011
Included observations: 39 after adjustments
LOG(SU005CONSTR)=0.6686*LOG(SU014KCONS(-1))+0.6686*0.31
*LOG(@MOVAV(SU013KELEC(-1)+SU053KTRANS(-1),3))+(1
-0.6686)*LOG(SU029LCONSTR)+(1-0.6686)*0.28
*LOG(SU021LITERACY)+(1-0.6686)*0.23*LOG(@MOVAV((SU054
KEDUC(-1)+SU055KHEALTH(-1))/POTOT(-1),3))+C(7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(7)	-2.046968	0.037062	-55.23059	0.0000
R-squared	0.779382	Mean dependent var		8.498204
Adjusted R-squared	0.779382	S.D. dependent var		0.492769
S.E. of regression	0.231453	Akaike info criterion		-0.063569
Sum squared resid	2.035687	Schwarz criterion		-0.020914
Log likelihood	2.239600	Hannan-Quinn criter.		-0.048265
Durbin-Watson stat	0.161654			

Dependent Variable: LOG(SU006TRADE)
Sample (adjusted): 1973 2011
Included observations: 39 after adjustments
LOG(SU006TRADE)=0.8858*LOG(SU015KTRAD(-1))+0.8858*0.18
*LOG(@MOVAV(SU013KELEC(-1),3))+0.8858*0.23
*LOG(@MOVAV(SU053KTRANS(-1),3))+(1-0.8858)
*LOG(SU030LTRADE)+(1-0.8858)*0.34*LOG(SU021LITERACY)
+(1-0.8858)*0.25*LOG(@MOVAV((SU054KEDUC(-1)
+SU055KHEALTH(-1))/POTOT(-1),3))+C(7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(7)	-4.315674	0.058516	-73.75242	0.0000
R-squared	-0.629619	Mean dependent var		9.695814
Adjusted R-squared	-0.629619	S.D. dependent var		0.286261
S.E. of regression	0.365430	Akaike info criterion		0.849825
Sum squared resid	5.074496	Schwarz criterion		0.892480
Log likelihood	-15.57158	Hannan-Quinn criter.		0.865129
Durbin-Watson stat	0.047158			

Dependent Variable: LOG(SU007OTHRSERV)
Sample (adjusted): 1973 2011
Included observations: 39 after adjustments
LOG(SU007OTHRSERV)=0.7453*LOG(SU016KOTHE(-1))+0.7453
*0.18*LOG(@MOVAV(SU013KELEC(-1),3))+0.7453*0.27
*LOG(@MOVAV(SU053KTRANS(-1),3))+(1-0.7453)
*LOG(SU031LOTHSERV)+(1-0.7453)*0.12*LOG(SU021LITERACY)
+(1-0.7453)*0.38*LOG(@MOVAV((SU054KEDUC(-1)
+SU055KHEALTH(-1))/POTOT(-1),3))+C(7)

	Coefficient	Std. Error	t-Statistic	Prob.
C(7)	-2.897129	0.060545	-47.85086	0.0000
R-squared	-0.877635	Mean dependent var		10.68922
Adjusted R-squared	-0.877635	S.D. dependent var		0.275934
S.E. of regression	0.378103	Akaike info criterion		0.918007
Sum squared resid	5.432557	Schwarz criterion		0.960663
Log likelihood	-16.90115	Hannan-Quinn criter.		0.933312
Durbin-Watson stat	0.027131			