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Determinants of Public Expenditure on Infrastructure

Transportation and Communication

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Governments that are not committed to alleviating poverty — or that are extremely committed to it — spend less from the central budget on infrastructure. Governments with only limited commitment to alleviating poverty adopt strategies to increase the productivity of the poor by investing in infrastructure. But as their commitment intensifies, their strategy shifts to improving human capital or strengthening the social safety net, and funding for social programs competes with funding for infrastructure.

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Summary findings

Randolph, Bogetić, and Heffley empirically study factors that influence public investment in transportation and communication infrastructure. Using pooled cross-national and time-series data for 1980–86 for 27 low- and middle-income economies, they assess the influence on public infrastructure spending of a government's objectives (especially its commitment to poverty alleviation), the nature of the domestic economy, and the flow (and composition) of external assistance. Their findings:

- Per capita spending on infrastructure responds most strongly to changes in the level of development, the urbanization rate, and the labor force participation rate.
- Spending is greater in countries with large foreign sectors and is positively influenced by sectoral imbalances between rural and urban areas (reflected in migration rates). Moreover, as the stock of infrastructure increases, so does per capita spending on it.
- If total flows of foreign savings increase, there is a small positive response in per capita spending. The composition of foreign savings matters: when commercial bank flows represent proportionately more of such flows, infrastructure spending is greater.
- With higher population densities, consolidated government spending declines. Central government spending increases initially, but decreases as population densities rise.
- Central budget spending is positively associated with improved institutional development, whereas consolidated budget spending falls as institutional development improves (when levels of institutional development are low).
- The size of the budget deficit appears not to influence central budget spending but is positively associated with consolidated budget spending.
- Greater outward orientation is positively associated with increased consolidated budget spending but seems to bear no relationship to central budget spending on infrastructure.
- Governments that are not committed to alleviating poverty, or that are extremely committed to it, spend less from the central budget on infrastructure. Governments with only limited commitment to alleviating poverty adopt strategies to increase the productivity of the poor by investing in infrastructure. But as their commitment intensifies, their strategy shifts to improving human capital or strengthening the social safety net, and funding for those social programs competes with funding for developing infrastructure.

This paper — a product of the Country Operations Division, Europe and Central Asia, Country Department I — is part of a larger effort in the department to analyze public expenditure issues. The study was funded by the Bank's Research Support Budget under the research project "Enhancing Urban Productivity: Determinants of Optimal Expenditure on Infrastructure, Human Resources, and Public Consumption Goods" (RPO 677-66). Copies of this paper are available free from the International Monetary Fund, 700 19th Street NW, Washington, DC 20431. Please contact Željko Bogetić, room IS3-574, telephone 202-623-7292, fax 202-623-4022, Internet address zbogetic@imf.org. October 1996. (72 pages)

DETERMINANTS OF PUBLIC EXPENDITURE ON INFRASTRUCTURE: TRANSPORTATION AND COMMUNICATION

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EXECUTIVE SUMMARY

Public infrastructure investment has the potential to open new markets, lower private production costs, reduce transaction costs, and increase competition. Recent studies document public infrastructure's stimulating impact on private investment. Along side this growing body of evidence substantiating the importance of public investment in infrastructure for development is an accumulation of evidence that infrastructure investment in LDCs is suboptimal. The primary objective of this study is to isolate the factors influencing public infrastructure investment. Pooled cross-national and time-series data covering 27 low and middle income economies over the 1980-1986 period are utilized to assess the relative influence of the internal features of an economy, government objectives, specifically the extent of commitment to poverty alleviation, and external assistance on observed infrastructure expenditures. Of particular relevance to Bank operations is the estimated influence of the level of foreign assistance and alternative forms of foreign assistance (official development assistance, commercial bank lending and direct foreign investment) on infrastructure expenditures.

The analytical framework guiding the estimations is a four-sector general equilibrium model consisting of urban households, urban producers, rural households and a single government. The model's solution determines the optimal level and mix of public expenditures on infrastructure, human resources and consumption public goods, and the optimal mix of taxes on wages, domestic output and property. The model generates a set of reduced form equations for several forms of government expenditures and taxes. The reduced form equation for infrastructure spending provides the departure point for the empirical analysis. The determinants of central government expenditures and consolidated government expenditures are estimated separately. The internal features of the economy considered include basic structural characteristics of the economy, including the existing stock of infrastructure, level of development, population density, urbanization, the rural-urban balance, the labor force participation rate, and institutional development; factors reflecting macro balance and strategy orientation including the size of the foreign sector, the government's budget balance, the external balance, debt obligations, and commitment to poverty redress; and external factors including terms of trade shifts, and foreign savings flows. Sensitivity analyses are undertaken to assess the robustness of the results to alternative definitions of each of these factors.

Most of the findings regarding the determinants of public infrastructure expenditures are broadly consistent regardless of whether central or consolidated budget expenditures are the focus of concern. The main findings are summarized below.

(1) Per capita infrastructure expenditures respond most strongly to changes in the level of development, the urbanization rate and the labor force participation rate. Elasticity estimates for these factors are all above 1.0 in absolute value at the sample mean. Of the three factors, the labor force participation rate has the strongest impact on infrastructure expenditures. Infrastructure expenditures increase with the level of development, as measured

by GDP per capita. The relationship is strictly linear if GDP per capita comparisons are made on the basis of purchasing power parity conversions, but in the central budget case, infrastructure expenditures increase at a decreasing rate when exchange rate conversions are used. Higher urbanization and labor force participation rates are associated with lower per capita infrastructure expenditures.

(2) The size of the foreign sector, the urban-rural balance and the stock of infrastructure are also important determinants of per capita infrastructure expenditure. Per capita infrastructure expenditures are greater in countries with a large foreign sector. The size of the foreign sector is a more important determinant of central government expenditures than consolidated budget expenditures, reflecting the fact that export and import taxes tend to accrue to the central government. A sectoral imbalance between rural and urban areas, as reflected in migration rates, positively influences per capita infrastructure expenditures. The relationship is strictly linear in the case of central budget expenditures, but dampens off in the case of consolidated budget expenditures. As the stock of infrastructure increases, so do per capita infrastructure expenditures.

(3) Per capita infrastructure expenditures respond positively to increases in the overall level of foreign savings flows, but the magnitude of the response is small. There is an important qualification. The composition of foreign savings matters; when commercial bank flows are a high proportion of foreign savings flows, infrastructure expenditures are larger. Also, as the share of direct foreign investment in total foreign savings increases, infrastructure expenditures initially decrease, but subsequently increase. There is only weak evidence that terms of trade shocks and debt service obligations significantly influence either central or consolidated budget expenditures, although the evidence is stronger for central government expenditures. The external (trade) balance does not have a significant influence on either central or consolidated budget infrastructure expenditures.

Several factors influence central and consolidated per capita infrastructure expenditures differently. Population density and institutional development are important determinants of both central and consolidated budget expenditures, but the nature of the relationship differs.

(4) While higher population densities are strictly negatively related to consolidated infrastructure expenditures, central government expenditures initially increase, but subsequently decrease as population densities rise.

(5) Central budget expenditures are positively associated with better institutional development, but consolidated budget expenditures fall as institutional development improves when levels of institutional development are low.

(6) While the size of the budget deficit does not appear to influence central budget infrastructure expenditures, it is positively associated with consolidated budget expenditures.

(7) Greater outward orientation is strongly and positively associated with increased consolidated budget infrastructure expenditures, but there is no apparent relationship between outward orientation and central budget expenditures on infrastructure.

(8) Finally, the central government's commitment to poverty influences central government expenditures on infrastructure. This is perhaps the most interesting result. The relationship is inverted U-shaped; governments that are not committed to poverty alleviation or have an extremely strong commitment to poverty alleviation spend less out of the central budget on infrastructure. This suggests that governments with some, but limited, commitment to poverty alleviation adopt strategies focused on increasing the poor's productivity through infrastructure investments, but that as the commitment to poverty alleviation intensifies the strategy shifts to one either fostering the poor's human capital accumulation or emphasizing the provision of a social safety net and that funding for these strategies competes with funding for infrastructure provision.

DETERMINANTS OF PUBLIC EXPENDITURE ON INFRASTRUCTURE: TRANSPORTATION AND COMMUNICATION[1]

I. WHY STUDY THE DETERMINANTS OF PUBLIC EXPENDITURE ON INFRASTRUCTURE?

The scope for investment in infrastructure and public consumption goods to increase urban productivity and national economic development is the subject of renewed attention in developing and transitional economies. Recent studies document the fact that public investment in infrastructure, such as roads, communications, and utilities, stimulates private investment. Blejer and Khan (1984), using a cross-country data set, find that public investment in infrastructure complements private investment. Greene and Villanueva (1991), using a panel of 23 developing countries, and Serven and Solimano (1993), using a panel of 15 countries, similarly find that public investment in infrastructure "crowds in" private investment. Time-series studies from single developing countries, such as Musalem's for Mexico (1989), also document the positive link between public investment in infrastructure and private investment. The *World Development Report 1994*, focussing on the link between infrastructure and development, expounds numerous ways in which policy can improve the *quality,* not only the quantity, of infrastructure services in less developed countries.

Many infrastructure investments have characteristics of public goods -- non-exhaustive and non-exclusive in consumption -- and thus will be undersupplied by the private sector. Yet, infrastructure investments facilitate private investment by lowering private production costs and opening new markets, thereby creating new opportunities for profit. Roads reduce transportation costs. Ports reduce transactions costs and facilitate trade, reducing the cost of input supplies and exposing domestic firms to the innovative forces of international competition. Telecommunications networks reduce transactions costs by increasing the flow of information and, as noted by Leff (1984), have important side effects that make other economic institutions more efficient. Norton (1992), using pooled time-series, cross-national data from 47 countries from post-World War II to 1977, finds that telecommunications networks not only increase investment, but also increase the rate of economic growth. Aschauer (1989, 1990) finds that road building increased economic growth in the United States.

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[1] This paper is the product of the research carried out by Susan Randolph, Zeljko Bogetic, and Dennis Heffley under the World Bank research project RPO-677-66 "Enhancing Urban Productivity: Determinants of Optimal Expenditure on Infrastructure, Human Resources and Public Consumption Goods". It is the product of the Country Operations Division, Department One, Europe and Central Asia Region of the World Bank. In the course of this research many World Bank economists and researchers provided invaluable advice, input and data for this project. Particularly, we want to thank Shantayannan Devarajan, William Easterly, Gregory Ingram, Marianne Fay, and Kyu Sik Lee for valuable discussions and for sharing several important draft papers on the subject. In addition, we would like to thank Matthew Baker, Fareed Hassan, Stephen Onyiwu, Sergey Rumyantsev, Fadel-Rahman Sesay and Hemanta Kum Shrestha for their contributions to data input and table preparation. The authors are solely responsible for the final product.

Along side the growing body of evidence substantiating the importance of investment in infrastructure for development (Heller and Diamond, 1990; Kessides, 1993a,b; World Bank, 1994) is an accumulation of evidence that infrastructure investment in LDCs is suboptimal. Cardoso (1993), using panel data from six Latin American Countries for the period 1970-85, partially attributes the decline in investment in Latin America to the decline in complementary public investment as countries adjusted to the debt crisis. Canning and Fay (1993) find that rates of return to transportation infrastructure may exceed 200 percent in poorer, newly industrializing countries and are around 50 percent in less developed agricultural economies, suggesting that transportation infrastructure is seriously undercapitalized.

In view of the direct impact of infrastructure investment on economic growth, the importance of public infrastructure investment for stimulating private investment and the mounting evidence of underinvestment in public infrastructure, especially in the wake of the debt crisis, the question of what determines the level of public investment in infrastructure naturally arises.

II. The Objectives of the Analysis

The primary objective of this study is to isolate the factors influencing the level of public investment in infrastructure. To this end, we analyzed pooled cross-national and time-series data to assess the relative influence of internal features and external assistance on observed expenditures on infrastructure. The analysis covers 27 low-income and middle-income economies over the 1980-1986 period. Of particular relevance to Bank operations is the estimated influence of the level of foreign assistance and alternative forms of foreign assistance, official development assistance, commercial bank lending, and direct foreign investment, on infrastructure investments after properly controlling for internal differences in these economies.

The analysis also explores the influence of government commitment to poverty alleviation on infrastructure investments. Three principle means exist to reduce poverty: promoting economic opportunities for the poor, providing social services to the poor and providing transfers to the poor (World Bank, 1990b). The primary role of transfers is to put a safety net below living standards, ensuring that the poor cannot fall below a threshold standard of living. However, this approach must be viewed as a stopgap measure; it does little to increase individuals' opportunities to rise above poverty once transfers cease. The provision of social services, especially health and education, in contrast, increases individuals' opportunities to rise above poverty by augmenting their human capital. Similarly, the promotion of economic opportunities for the poor directly enhances individuals' opportunities to avoid poverty, but this time by augmenting their access to assets and increasing the return to those assets. The provision of infrastructure such as rural feeder roads, electrification, irrigation or urban infrastructure supporting small scale industry, serves both of these ends. As such, a government's commitment to poverty alleviation may influence infrastructure expenditures. However, to the extent that increasing the poor's human capital or putting a safety net in place are viewed as more effective or politically feasible strategies for poverty alleviation, competition for scarce government resources could negatively impact general infrastructure expenditures in countries committed to poverty alleviation.

III. Conceptual Framework and Model Specification

The analytical framework is a four-sector general equilibrium model, consisting of urban households, urban producers, rural households and a single government. (See Appendix A for details of the model.) Total population of the economy is fixed, but households may migrate between the rural and urban sectors in response to perceived differences in utility levels. The model is solved to determine the optimal level and mix of public expenditures on infrastructure, human resources and consumption public goods, and the optimal mix of taxes on wages, domestic output and property. The model can be used for simulating the impacts of changes in various policy variables. Thus, simulations can be used to explore the influence of: (1) internal features of the economy, (2) the level and mix of external funding, and (3) the specified goal(s) of the government. The model implies a set of reduced form equations for several forms of government expenditures and taxes. In this paper, however, we primarily use the model's reduced form solution for infrastructure spending as a departure point for the empirical analysis, which is at the heart of this paper.

The reduced-form equation for infrastructure expenditures takes the following form: $I = I(V, E, O)$ where V is a vector of characteristics defining the economy, E is the level and composition of external assistance and O reflects government objectives. Some of the characteristics in V are dictated by the formal structure of the theoretical model; others are additional control variables that have been hypothesized in the literature to influence the level of total government expenditure or the ability of the government to collect taxes. The vector V also incorporates variables capturing differences in structural features between countries. The vector E includes the net flow of foreign assistance and variables reflecting the proportion of foreign assistance accounted for by official flows, commercial bank flows, and direct foreign investment. All governments are assumed to emphasize growth, but governments are viewed as differing in their commitment to alleviating poverty. Thus, the vector O is a single variable reflecting the government's commitment to poverty alleviation. Against this background, we now turn to the description of the categories of variables considered along with their hypothesized influence on infrastructure expenditures.

A. Dependent Variable: Per Capita Infrastructure Spending

The dependent variable is per capita government expenditures on transportation and communications measured in constant 1980 US dollars.[1] The determinants of *central* government expenditures (BTACCAPK) and *consolidated* government expenditures (CTACCAPK) are estimated separately.[2] The data source for central and consolidated government expenditures is the *Government Finance Statistics Yearbook* (IMF, various years)[3]. Conversion to per capita constant 1980 US dollars is accomplished using data from the *World Development Report 1991: Supplementary Data* (World Bank, 1991).

B. Independent Variables

There are three sets of explanatory variables used in this study. They reflect the model's implications, implications from the previous empirical work, and basic intuition regarding factors affecting infrastructure spending. In a nutshell, we postulate that infrastructure spending per capita depends on factors related to the domestic economy, external financial assistance and the government's preferences, as revealed by various spending policies. Thus, we organized the three sets of variables as ones that define:

- Characteristics of the economy
- Level and mix of external funding
- Government objectives

1. Characteristics of the Economy

There are five variables, implied by the structure of the underlying theoretical model, which define the characteristics of the domestic economy. These are: (i) the existing stock of infrastructure, (ii) population density, (iii) urbanization, (iv) urban-rural balance, and (v) labor force participation rate.

1.1. Existing Stock of Infrastructure: Two opposing forces dictate the influence of the existing stock of infrastructure on current expenditures on infrastructure. First, it is hypothesized that there are diminishing returns to infrastructure expenditures such that, *ceteris paribus*, countries with high stocks of infrastructure are expected to derive less benefit from additional expenditures on infrastructure and accordingly spend less. Second, the greater the stock of infrastructure, the greater the expenditure required to offset depreciation of the existing stock. Further, previously high levels of infrastructure expenditure may reflect a greater degree of complementarity between infrastructure and the existing productive structure of the economy, dictating higher optimal levels of current infrastructure expenditure. Overall then, the direction of influence of the existing stock of infrastructure is uncertain and reflects the relative strength of the opposing forces.

Sensitivity analysis is performed to determine the sensitivity of the results to alternative measures of the stock of infrastructure. Two different classes of variables are used to measure the existing stock of infrastructure. The first is the total kilometers of roads plus railways relative to GDP per capita in constant 1980 US dollars (FCINFGDP) or per thousand square kilometers land area (FCINFPA) or per person (FCINFPP). The data on kilometers of roads and railways are those compiled by Canning and Fay and used as the basis for their 1993 paper. The Canning and Fay data are available for five year intervals. Linear and nonlinear methods were used to interpolate the data across five-year intervals. The data source for kilometers of land area and population is the *World Development Report 1991: Supplementary Data* (World Bank, 1991). The second class of variable is an estimate of the total capital stock (public plus private) constructed using the perpetual inventory method. The data source for this variable (KO2) is also the *World Development Report 1991: Supplementary Data* (henceforth, WDR91SD).

Neither class of variables is a fully satisfactory measure of the stock of infrastructure. The first class of variables seriously underestimates the total stock of infrastructure.[4] To the extent that there is a strong positive correlation between road and rail infrastructure and other forms of transport and communication infrastructure, the effect is only a scale effect and the ranking by country is correct. However, if the ratio between road and rail infrastructure on the one hand, and other forms of transport and communication infrastructure on the other, differs substantially, the estimates will be biased and the direction of the bias is unknown. The second class of variables includes private as well as public capital stock. The relationship between the size of the private capital stock and current government investment in infrastructure depends upon whether infrastructure investment is a net substitute or complement to production. As noted earlier, available evidence suggests complementarity between private and public capital, thus KO2 should be a multiple of the stock of public transport and communications infrastructure. However, not enough information has accumulated to determine whether the degree of complementarity is more or less constant across countries and, accordingly, the likely extent of measurement error.

1.2. Population Density: Low population density necessitates higher expenditure for a given level of infrastructure service. For example, in sparsely populated countries the miles of telephone wire needed to link two households will be greater, as will the miles of road needed to link two population centers or to link rural and urban markets. This influence implies that per capita infrastructure expenditures will be inversely related to population density. However, certain kinds of infrastructure expenditure, such as sewage systems and treatment facilities, are of limited importance when population densities are low. On this basis, infrastructure expenditures would be positively related to population density. Further, economies of scale may dictate a higher optimal level of infrastructure provision in more densely populated countries. Overall then, the influence of population density on infrastructure expenditures is uncertain.

Population density (DENS) is measured as population per square kilometer and is computed from data on the total population and the total land area in square kilometers. The data source for both components of DENS is WDR91SD.

1.3. Urbanization: If economies of scale in infrastructure provision dominate, then *ceteris paribus*, countries with a higher proportion of the population in urban areas are expected to spend less on infrastructure per capita. While this force is expected to dominate, opposing forces are at work as well. Urbanization entails specialization and hence less self-provision. Whereas a family may dig their own well, and a village may be mobilized to build or repair a footpath or road, urban populations are more likely to rely on government provision of these types of infrastructure services (Heller and Diamond, 1990). Further, to the extent there is an urban bias in service provision, or if agglomeration economies increase the return to infrastructure expenditures in urban areas, higher urbanization rates imply higher levels of infrastructure service provision.

Urbanization (URBAN4) is measured as the annual percentage of total population living in urban areas, interpolated from five-year intervals. The data source for URBAN4 is WDR91SD.

1.4. Urban-Rural Balance: The extent of the difference between urban and rural utility levels is hypothesized to influence rural-urban migration rates, and accordingly the pressure on governments for urban services, including infrastructure provision. Further, governments may respond by attempting to increase rural productivity (and utility) in an effort to slow rural-urban migration. Rural infrastructure investments supporting agricultural intensification or rural industry offer one means to increase rural productivity. Both forces imply current expenditures on infrastructure will be positively related to the size of the differential between urban and rural utility or earnings levels.

Sensitivity analysis is conducted to determine the sensitivity of results to three alternative measures of the urban-rural balance. In the theoretical model, a utility balance between the urban and rural sectors is maintained through migration. The first measure of the urban-rural balance is a proxy for the rural-to-urban migration rate (MIGZ). MIGZ is defined as the urban population growth rate minus the total population growth rate. The data source for the urban and total population growth rates is the *Social Indicators of Development 1990* (World Bank, 1990). The second measure of the urban-rural balance is the agricultural GDP per capita in constant 1980 US dollars (AGCAPK). AGCAPK is calculated as the percentage share of agriculture in GDP, multiplied by GDP in constant 1980 US dollars, all divided by the product of the total population and 1 minus the percentage urban population. The data source for the component variables is WDR91SD. The greater the difference between GDP per capita and AGCAPK, the greater the urban-rural imbalance. Because total GDP per capita is included in all regression models (see 2.1 below) the coefficient of AGCAPK measures the impact of per capita agricultural income, holding GDP per capita constant. The lower the value of AGCAPK, the greater the urban-rural imbalance. The third measure of the urban-rural balance is the percentage share of agriculture in GDP (SAGR4). As noted above, the data source for this variable is WDR91SD. Because both aggregate GDP per capita and the percentage urban population are included in all regressions, the smaller is SAGR4 the greater is the urban-rural imbalance.

1.5. Labor Force Participation Rate: In the theoretical model, households supply an amount of labor that is fixed in physical units (e.g., person-years). The labor force participation rate is utilized here to capture differences between countries in the physical amount of labor households supply. Public expenditure on infrastructure influence firm demand for labor, and accordingly, the wage per efficiency unit of labor supplied.[5] The relationship between the labor force participation rate and public expenditures on infrastructure depends upon whether labor and public infrastructure investments are complements or substitutes in production. If they are complements, then infrastructure expenditures will increase as the labor force participation rate increases. If they are substitutes, the opposite will hold. This relationship is likely to differ for various categories of labor and different types of infrastructure, so our empirical results will simply capture the net effects. To the extent that the labor force participation variable also may be correlated with the population growth rate (i.e., high growth rates may imply a relatively low proportion of the population in the economically active age cohorts), the estimated regression coefficient may reflect even more than just the net substitutability or complementarity of infrastructure and labor.

The size of the labor force participation rate (LFPER) is computed as the total labor force (the "economically active" population including the employed, the unemployed, and the armed forces, but excluding homemakers, care givers, and students) divided by the total population, all multiplied by 100. The data source for both component variables is WDR91SD.

2. Other Variables Reflecting the Structure of the Economy

No theoretical model is complete enough to provide a full list of variables that may be important in the empirical investigation of many economic phenomena. The stylized model that we use as departure point for our analysis does not pretend otherwise. Therefore, in addition to the above variables implied by the model, based on the previous empirical studies, we also included the following variables defining the domestic economy: the level of development, internal government budget balance, external balance, the size of the foreign sector, terms of trade shifts, debt obligations and institutional development.

2.1. Level of Development: Most government services and goods are expected to be normal goods. Accordingly, as income increases, the demand for infrastructure is similarly expected to increase, although possibly at a diminishing rate. Further, as the level of development increases, the structure of the economy is expected to change in ways that increase the productivity of infrastructure investment. For example, industrialization accompanies development and infrastructure may well be more productive to industry than agriculture.

Level of development is measured as real GDP per capita. Sensitivity analysis is conducted to ascertain the sensitivity of the results to two alternative formulations of real GDP per capita. The first measure is GDPCAPK. Here, currency conversions are accomplished using dollar exchange rate conversions and all values are deflated to 1980 US dollars. GDPCAPK is computed as total GDP in constant 1980 US dollars divided by total population. The second measure, GDPCAP2, measures real per capita income at international prices using the Summers-Heston data. The data series used to construct GDPCAPK along with GDPCAP2 are contained in WDR91SD.

2.2. Internal Balance: A high government deficit in the previous year is expected to decrease government expenditures in the following year and, therefore, the government's ability to make infrastructure investments in the current period. Similarly, maintenance is likely to be postponed in the context of high government deficits (Easterly, Rodriguez and Schmidt-Hebbel, 1994). Accordingly, the higher the government deficit in the previous period (the greater the internal imbalance), the lower the level of infrastructure expenditures expected. However, several opposing forces may be at work as well. First, the uncertain investment climate caused by deficit induced inflation implies that the government may choose to increase infrastructure investment to compensate for or stimulate private investment. Further, the existence of high deficits in the past may signal the inability or unwillingness of governments to undertake the hard decisions necessary to bring the budget into balance and, accordingly, their unwillingness to lower infrastructure service provision. Overall then, the relationship between the internal balance and current infrastructure expenditures is uncertain.

The measure of internal imbalance used, BBGDPL, is the budget balance as a percentage of GDP (with a negative value implying a deficit), lagged one year. Nominal values in domestic currency of both the budget balance and GDP are the basis of the computation. The data source for the component variables is the World Bank's *World Tables 1993*. Analysis is undertaken to explore the sensitivity of results to an alternative measure of internal imbalance, the domestic inflation rate, INFL4, given the link between internal balance and domestic inflation. This variable captures the ability of the government to sustain a deficit without serious inflationary consequences. INFL4 is calculated as log differences of the Consumer Price Index, when it exists, and the log differences of the Wholesale Price Index otherwise. The data source for INFL4 is WDR91SD.

2.3. External Balance: *A priori*, the relationship between the external balance and infrastructure expenditures is unclear. On the one hand, countries with large imbalances in their current account in the previous period are likely to adopt or have imposed on them stabilization policies which include reining in government expenditures. That is, all government expenditures, including expenditures on infrastructure, are likely to decrease when the external balance is negative. In addition, the maintenance of a positive trade balance implies that policies are being pursued which maintain international competitiveness. A force in the opposite direction concerns the fact that the correction of structural current account imbalances may entail increased infrastructure investments. That is, governments facing imbalances need to increase their capacity to export and this may necessitate shifting a larger proportion of government expenditures to infrastructure expenditures on ports or other infrastructure investments supporting export growth. Overall, the impact of the external balance on infrastructure expenditures is uncertain.

Several alternative indicators of the external balance are considered. The first is the trade balance as a proportion of GDP, lagged one year, TBWTGDPL. The trade balance for a given year is calculated as the value of exports minus imports, all divided by GDP (all measured in current local currency). The data source for the value of exports minus imports (resource balance) and GDP is the World Bank's *World Tables 1993*. The second measure of external balance considered is the black market foreign exchange premium, BLACK. The premium is based on the differences between official exchange rates and black market rates and is calculated as 100 times the black market exchange rate minus the official exchange rate all divided by the official exchange rate. The source for BLACK is WDR91SD, which compiled data on the Black market exchange rate from the *World Currency Yearbook*. Finally, a purchasing power parity-based outward orientation index, DOLLAR4, is considered. This index was calculated by David Dollar,[6] and is the weighted average of the mean price distortion between 1973 and 1985 and its standard deviation. The weights are the estimated coefficients from a regression of GDP growth on the average price distortion over the period and its standard deviation. The range of DOLLAR4 for the countries examined by David Dollar was 96 to just over 102. Higher values of DOLLAR4 are associated with greater outward orientation.

2.4. Size of the Foreign Sector: The taxable capacity of a government is generally expected to be greater, the greater is the size of the foreign sector. Imports and exports provide an accessible tax base and are important sources of revenue in developing countries. Greater tax revenue supports greater government expenditure. To the extent that taxable capacity limits the ability of governments to invest in the optimal level of infrastructure, governments are likely to increase expenditures on infrastructure when the size of the foreign sector is large. In addition, a large foreign sector likely entails greater competitiveness. To the extent that infrastructure investments increase the competitiveness of industry, larger foreign sectors are likely to be associated with higher expenditures on infrastructure.

The size of the foreign sector, TVALX2, is measured as the share of imports and exports of goods and nonfactor services in GDP. The data source for TVALX2 is WDR91SD.

2.5. Terms of Trade Shifts: A deterioration in the terms of trade is expected to reduce taxable capacity, forcing a government to scale back expenditures if a deterioration in the internal balance is to be prevented. Unless the composition of expenditures shifts, infrastructure investments will be proportionately reduced. They may be more than proportionately reduced if falling incomes trigger increased transfer payments or increase the pressure on the government to provide consumption goods and services to offset the decline in income. Thus, an improvement in the terms trade and government expenditures on infrastructure are expected to be positively related.

The magnitude of the terms of trade shock, TOTS, is measured as the percentage change in the terms of trade during the previous year. It is calculated from the terms of trade index TOT4 in WDR91SD as $(TOT4_t/TOT4_{t-1}) - 1$ all multiplied by 100, where the subscript t refers to the current year. TOT4 is indexed to 100 in 1980 and measures the terms of trade as the export unit price/import unit price. Accordingly a negative value of TOTS reflects a deterioration in the terms of trade and a positive value reflects an improvement.

2.6. Debt Obligations: It is hypothesized that, overall, a larger debt obligation will decrease government expenditure on infrastructure, given the likely dominance of this obligation over more discretionary government expenditures such as outlays on infrastructure. However, it is also recognized that a large debt obligation results, in part, from the capacity of governments to attract foreign savings. To the extent that a large debt obligation also reflects the continued ability of governments to attract foreign savings, unless the current net flow of foreign savings is controlled for in the regression, an opposing positive relationship between the debt obligation and infrastructure expenditures may be observed.

Three alternative measures of the debt obligation are considered. The first, DSGDP, is debt service obligations (interest and amortization on total external debt) as a percentage of GDP. It is computed as the total debt service ratio (interest and amortization on total external debt as a percentage of export revenues) multiplied by the value of exports in current local currency, all divided GDP in current local currency. The data source for the debt service ratio is WDR91SD, while that for the local currency value of exports and GDP is *The World Tables 1993*. This formulation of debt obligations emphasizes the magnitude of the debt burden relative to the total productive capacity of the economy. A second formulation focus on obligations relative to the economy's capacity to generate foreign exchange. TDS is the traditional debt service ratio, the value of interest and amortization on total external debt as a percentage of export revenues. As noted earlier, the data source for this variable is WDR91SD. Finally, long-term debt as a percentage of GDP, DODGDP1, is considered. The data source for this variable is also WDR91SD.

2.7. Institutional Development: It is not clear, *a priori*, how institutional development is likely to influence infrastructure expenditures. Where institutional development is strong, transactions costs are lowered and the ability of the private sector to take over the supply of some forms of infrastructure provision may increase. On the other hand, where institutional development is strong, the market is likely to flourish, increasing private investment and the demand for complementary public infrastructure.

The variable used to measure the level of institutional development, GASTIL, is the arithmetic average of two indices, one measuring political liberties, GAS_POL, and the other civil liberties, GAS_CIV. The index of civil liberties is a measure of the extent to which people are able to freely express their opinions. The index of political rights is designed to measure the extent to which individuals have the right to participate meaningfully in the political process. These variables are indices with values from 1 (most democratic/free) to 7 (least democratic/free). Accordingly, lower values of GASTIL correspond to higher levels of institutional development. The data source for GASTIL is WDR91SD.[7]

3. The Level and Mix of External Funding

Both the level and the mix of external funding influence the level of infrastructure spending. The level of foreign saving is important as it is often provided directly for financing specific investment projects. In addition, given the level of foreign savings used to finance infrastructure spending, the composition of foreign flows matters. For example, foreign direct investment is often contingent on an externally perceived adequacy of business infrastructure.

3.1. The Level of Foreign Funding: The relationship between the net flow of foreign savings and infrastructure investment is expected to be positive (Khan and Hoshino, 1992). Foreign savings directly provide funds for investment in infrastructure. Foreign savings provided for non-infrastructure expenditures free funds for infrastructure investment (foreign savings are fungible).

The total level of foreign savings flows is defined as the sum of official flows, private flows (commercial bank, other private guaranteed and non-guaranteed), direct foreign investment and other long-term net inflows per capita in constant 1980 US dollars. Two variants of foreign savings inflows are considered, differing by whether credits from the IMF are included or excluded from the tally of official flows. The first measure, NFFCAP1K, includes IMF credits, the second, NFFCAP2K, excludes IMF credits. The data source for the component variables measuring foreign savings flows is WDR91SD. Specifically, the variables MLDN5 (multilateral debt), NOTN5 (net official transfers) and, in the case of NFFCAP1K, IMFCN5 (IMF credits) are the component variables for official flows, CBN5 (commercial bank), OPGN5 (other private guaranteed), and PNGN5 (private non-guaranteed) are the component variables for private flows, DFIN5 measures direct foreign investment and OLTNIN5 measures net other long term flows. These nominal flows are then converted to constant 1980 dollars and divided by the population for the year concerned, using data from WDR91SD. Sensitivity analysis is conducted to determine whether IMF credits affect infrastructure expenditures differently than other sources of foreign savings.

3.2. The Mix of Foreign Funding: Given the level of net foreign flows, the amount of direct foreign investment is expected to increase public investment in infrastructure, given the perception in the literature that foreign investors demand infrastructure as a condition to invest in the country concerned. There is no strong perception that donor or commercial bank priorities emphasized infrastructure investments over the past decade (Khan and Hoshino, 1992, provide some evidence to the contrary). Accordingly, given the level of total net foreign flows, the level of official and commercial bank flows are not expected to influence the level of infrastructure expenditures.

The influence of the mix of foreign funding is captured by alternately including in the regressions variables measuring the level of official (NOFGDP), commercial bank (NCBGDP), or direct foreign investment (DFIGDP) flows as percentages of GDP. Again, two measures of official foreign flows are considered. The first, NOFGDP1, includes IMF credits and the second, NOFGDP2, excludes IMF credits. The data source for the component variables used to construct these variables is WDR91SD. Official, commercial bank and direct foreign investment are defined as above in the discussion of the total level of foreign funding.

4. Government Objectives

Preferences of government matter in observed public expenditure patterns and infrastructure spending is no exception. In other words, government spending always reflects government priorities and, implicitly, their objectives. We attempted to include this basic fact in our analysis by constructing a variable that would approximate the government objectives which are consistent with the observed infrastructure investment spending. An implied link between infrastructure spending (particularly in low income countries, and in rural areas) and poverty alleviation has been a key argument for public expenditure on infrastructure in many less developed countries. To pin down this link, we constructed a Poverty Commitment Index which measures the degree to which the government is declaratively committed to the eradication of poverty. We use this index to empirically study the presumed links between infrastructure spending and the government's objectives to eliminate poverty.

4.1. Poverty Commitment: In most developing economies the majority of the poor reside in rural areas. Productivity enhancing infrastructure investment in rural areas is one means of reducing poverty. Accordingly, governments with a higher commitment to poverty alleviation may devote a larger share of expenditures to infrastructure investments. However, given the scope for reducing poverty via increasing health and education expenditures or through the provision of social safety nets, and the fact that these expenditures compete with infrastructure expenditures, the overall impact of a government's commitment to reducing poverty on infrastructure expenditures is uncertain.

Concern is focused on the explicit commitment of leaders and policy makers to poverty alleviation rather than the existence of poverty per say. While a high level of poverty may create political pressures for poverty redress, high levels of poverty can result from a lack of commitment to poverty alleviation. As such, the incidence of poverty was rejected as an adequate proxy for poverty commitment. We are unaware of any existing data source that attempts to measure the degree of commitment to poverty alleviation for a large number of developing countries. For the purposes of this project an effort was launched to create a variable capturing the degree of poverty commitment across developing countries.

Our interest was to go beyond the rhetoric of political leaders and ascertain whether the rhetoric reflected credible intentions and actions. A thorough content analysis of official reports, national development plans, information bulletins and books covering the 1980-90 period, produced information upon which ordinal rankings of the degree of commitment to poverty alleviation were made.[8] Countries were ranked on a five point scale depending upon the degree of poverty alleviation commitment. A value of 1 was assigned if there was no mention of any commitment to poverty alleviation in the documents reviewed. A value of 2 was assigned to countries when poverty alleviation was only casually or occasionally mentioned as a concern. A value of 3 was assigned to countries where rhetoric calling for poverty alleviation was frequently found in the documents reviewed, but there was no evidence that this intention had been translated into on-going programs, projects or policies.

A value of 4 was assigned to countries when rhetoric promoting poverty alleviation was backed by some credible poverty alleviation policy, program or project. Finally, countries were assigned a value of 5 when there was overwhelming evidence of a strong and credible commitment to poverty alleviation. Only countries backing rhetoric with systematic action resulting in the implementation of a well defined and coordinated set of policies, programs and projects were assigned a value of 5. The variable PCOM is the result of this effort.

Table 1 shows the Pearson Correlation Coefficient between PCOM and several alternative efforts to rank absolute poverty across countries. HDRPOOR, is the percentage of individuals below the United Nations Development Program's poverty line, defined as "that income level below which a minimum nutritionally adequate diet plus essential non-food requirements are not affordable" (UNDP, 1992 pg. 208-209).[9] The correlation between PCOM and HDRPOOR is significantly (less than 1 percent level) negative. WBPOOR is the incidence of poverty reported in Table 3.2 of the *World Development Report 1990* (World Bank, 1990, pg. 41) and for Zambia, Egypt, Tunisia and Bangladesh from "The Report of the Task Force on Poverty Alleviation" (World Bank, 1988). PCOM is positively and significantly (5 percent level) correlated with WBPOOR. Finally, comparable poverty indicators for 40 countries in 1985 are provided by Chen, Datt and Ravallion (1993). Several alternative poverty lines are considered. P2185 bases the poverty assessment on a poverty line of $21 per month in 1985 PPP dollars. For P3085 the poverty line is set at $30.42 per month (1985 PPP) while for P6085 the poverty line is $60 per month (1985 PPP). PCOM is not significantly correlated with any of these indicators. It should be noted that all of the alternative poverty indicators are positively and significantly correlated with each other.

Sensitivity analysis is conducted to determine whether our results are sensitive to the exclusion of PCOM from the analysis and the substitution of the alternative indicators of poverty incidence for PCOM.

IV. Results

In this section we present the results of empirical analyses. First, basic summary statistics are provided. Second, findings concerning the determinants of central budget per capita expenditures on infrastructure are presented. This is followed by a presentation of the findings for the determinants of consolidated budget per capita expenditures. For both central and consolidated budgetary expenditures, the results of alternative base models, differentiated by how the existing stock of infrastructure is measured, are first presented. This is followed by a discussion of the results from sensitivity analyses. The final section summarizes the findings by comparing and contrasting the results concerning the determinants of per capita central versus consolidated budget expenditures on infrastructure.

Table 1. Correlation Between PCOM & Poverty Indicators

	PCOM	HDRPOOR	WBPOOR	P2185	P3085	P6085
PCOM	1.00*** 0.0000 (321)	-0.382*** 0.0001 (164)	0.252** 0.0209 (84)	-0.034 0.6492 (183)	-0.013 0.8590 (183)	0.043 0.5596 (183)
HDRPOOR	-0.382*** 0.0001 (164)	1.00*** 0.0000 (172)	0.642*** 0.0001 (65)	0.248** 0.0111 (104)	0.350*** 0.0003 (104)	0.613*** 0.0001 (104)
WBPOOR	0.252** 0.0209 (84)	0.642*** 0.0001 (65)	1.00*** 0.0000 (99)	0.330*** 0.0026 (81)	0.366*** 0.0008 (81)	0.513*** 0.0001 (81)
P2185	-0.034 0.6492 (183)	0.248** 0.0111 (104)	0.330*** 0.0026 (81)	1.00*** 0.000 (190)	0.964*** 0.0001 (190)	0.778*** 0.0001 (190)
P3085	-0.013 0.8590 (183)	0.350*** 0.0003 (104)	0.366*** 0.0008 (81)	0.964*** 0.0001 (190)	1.00*** 0.0000 (190)	0.8918*** 0.0001 (190)
P6085	0.0434 0.5596 (183)	0.613*** 0.0001 (104)	0.513*** 0.0001 (81)	0.778*** 0.0001 (190)	0.892*** 0.0001 (190)	1.00*** 0.0000 (190)

Note: Pearson Correlation Coefficient is the first entry, below it is the significance level, followed by the number of observations in parentheses.
*** Significant at the .01 level or better
** Significant at the .05 level or better

A. Summary Statistics

The analyses are run separately for central budget and consolidated budget per capita infrastructure expenditures, as noted earlier. Table 2 shows the means and standard deviations of all variables included in the analyses for countries where data on central budget infrastructure expenditures exist, while Table 3 provides the means and standard deviations of variables when data on consolidated budget infrastructure expenditures exist. The mean per capita expenditure on infrastructure in the sample is (1980) US $17.73 for the central budget and (1980) US $19.67 for the consolidated budget.

Table 2. Means of Central Budget Infrastructure Expenditure Data

Variable Code	Variable Definition	N	Mean	Std. Dev.	Minimum	Maximum
BTACCAPK	Central Budget Per Capita Infrastructure Expenditures in 1980 US $	150	17.73	16.71	0	88.82
FCINFPA	Kilometers Roads & Rail Per 1000 Square Kilometers Area	150	255.63	276.72	33.25	1406.14
FCINFPP	Kilometers Roads & Rail Per Capita	150	3.77E-3	2.91E-3	7.25E-4	1.33E-2
FCINFGDP	Kilometers Roads & Rail Relative to 1980 $ GDP	150	199.63	474.44	1.18	2657.80
GDPCAPK	Per Capita Gross Domestic Product in 1980 US $	150	1122.55	726.91	250.33	2940.47
GDPCAP2	Per Capita Gross Domestic Product in PPP (Summers-Heston 1988)	129	1834.19	1079.18	313.00	4576.00
DENS	Population Per 1000 Square Kilometers	150	105.01	129.73	5.49	515.00
URBAN4	Percentage Urban Population	150	42.00	17.77	16.10	84.00
MIGZ	Rural-Urban Migration Rate (Urban growth - population growth)	150	1.61	1.64	-2.66	9.14
SAGR4	Agricultural Output as a Percentage of GDP	143	21.09	9.28	7.11	45.36
AGCAPK	Agricultural GDP Per Capita in 1980 US $	143	394.30	269.65	95.94	1249.83
LFPER	Labor Force as a Percentage of Population	150	36.53	5.76	27.61	51.72
BBGDPL	Budget Balance as a Percentage of GDP Lagged One Year (Negative Value Implies Deficit)	150	-6.30	5.11	-31.05	5.41
INFL4	Inflation Rate	141	26.23	49.71	0.31	477.49
TVALX2	Share of Imports and Exports in GDP	150	0.22	0.11	0.05	0.51
TBWTGDPL	Trade Balance as a Percentage of GDP Lagged One Year	150	-3.87	6.50	-22.58	13.90
BLACK	Black Market Foreign Exchange Premia	150	33.16	70.19	-10.34	500.00
DOLLAR4	David's Purchasing Power Parity Outward Orientation Index	126	100.63	1.10	97.00	102.00
TOTS	Percentage Change in Terms of Trade From Last Year	150	-2.32	10.20	-50.33	35.14
DSGDP	Interest & Amortization on Total External Debt as a % of GDP	150	6.81	3.48	0.72	21.26
TDS	Debt Service Ratio (Total Debt)	150	0.30	0.16	0.04	0.81
DODGDP1	Long Term Debt as a Percentage of GDP	150	47.80	28.35	10.50	143.00
GASTIL	Level of Institutional Development	150	4.35	1.40	1.00	7.00
PCOM	Commitment to Poverty Alleviation	150	3.44	1.20	1.00	5.00
HDRPOOR	Human Development Report's Poverty Incidence	86	35.14	16.51	12.00	71.00
WBPOOR	World Development Report's Poverty Incidence	54	27.37	8.71	14.00	43.00
P2185	Ravallion's Poverty Incidence: $21/month in 1985 PPP	109	20.00	17.48	2.04	58.94
P3085	Ravallion's Poverty Incidence: $30.42/month in 1985 PPP	109	33.12	20.96	7.11	72.96
P6085	Ravallion's Poverty Incidence: $60/month in 1985 PPP	109	61.65	18.50	35.19	94.94
NFFCAP1K	Net Foreign Flows Inclusive of IMF Flows in 1980 US $	150	52.41	99.83	-377.20	771.47
NFFCAP2K	Net Foreign Flows Exclusive of IMF Flows in 1980 US $	150	47.94	94.05	-368.35	707.65
NOFGDP1	Net Official Flows Inclusive of IMF Flows as a % of GDP	150	2.75	2.57	-0.91	11.55
NOFGDP2	Net Official Flows Exclusive of IMF Flows as a % of GDP	150	2.31	1.98	-0.54	11.59
NCBGDP	Net Commercial Bank Flows as a % of GDP	150	0.80	1.71	-7.67	6.34
DFIGDP	Net Direct Foreign Investment Flows as a % of GDP	150	0.69	1.09	-1.52	5.21
Y80	Dummy Variable Set to 1 if Year is 1980	150	0.15	0.36	0.00	1.00
Y81	Dummy Variable Set to 1 if Year is 1981	150	0.14	0.35	0.00	1.00
Y82	Dummy Variable Set to 1 if Year is 1982	150	0.13	0.34	0.00	1.00
Y83	Dummy Variable Set to 1 if Year is 1983	150	0.14	0.35	0.00	1.00
Y84	Dummy Variable Set to 1 if Year is 1984	150	0.15	0.35	0.00	1.00
Y85	Dummy Variable Set to 1 if Year is 1985	150	0.15	0.35	0.00	1.00
Y86	Dummy Variable Set to 1 if Year is 1986	150	0.14	0.35	0.00	1.00

Table 3. Means of Consolidated Budget Infrastructure Expenditure Data

Variable Code	Variable Definition	N	Mean	Std. Dev.	Minimum	Maximum
CTACCAPK	Consolidated Budget Per Capita Infrastructure Expenditures in 1980 US $	132	19.67	16.64	0	88.82
FCINFPA	Kilometers Roads & Rail Per 1000 Square Kilometers Area	132	252.82	285.09	33.25	1406.14
FCINFPP	Kilometers Roads & Rail Per Capita	132	3.77E-3	3.14E-3	7.25E-4	1.33E-2
FCINFGDP	Kilometers Roads & Rail Relative to 1980 $ GDP	132	217.59	504.30	1.18	2657.80
GDPCAPK	Per Capita Gross Domestic Product in 1980 US $	132	1152.52	762.26	250.34	2940.47
GDPCAP2	Per Capita Gross Domestic Product in PPP (Summers-Heston 1988)	113	1858.18	1118.02	313.00	4576.00
DENS	Population Per 1000 Square Kilometers	132	108.52	134.95	5.49	515.00
URBAN4	Percentage Urban Population	132	41.38	17.72	16.50	84.00
MIGZ	Rural-Urban Migration Rate (Urban growth - population growth)	132	1.65	1.58	-0.67	9.14
SAGR4	Agricultural Output as a Percentage of GDP	129	20.69	9.04	7.11	45.36
AGCAPK	Agricultural GDP Per Capita in 1980 US $	129	398.63	284.04	95.94	1249.83
LFPER	Labor Force as a Percentage of Population	132	36.93	5.74	27.61	51.72
BBGDPL	Budget Balance as a Percentage of GDP Lagged One Year (Negative Value Implies Deficit)	132	-6.57	5.39	-31.05	5.41
INFL4	Inflation Rate	123	25.25	52.00	0.35	477.49
TVALX2	Share of Imports and Exports in GDP	132	0.23	0.12	0.05	0.51
TBWTGDPL	Trade Balance as a Percentage of GDP Lagged One Year	132	-3.76	6.92	-22.58	13.90
BLACK	Black Market Foreign Exchange Premia	132	31.78	69.98	-10.34	500.00
DOLLAR4	David's Purchasing Power Parity Outward Orientation Index	110	100.60	1.13	98.00	102.00
TOTS	Percentage Change in Terms of Trade From Last Year	132	-1.96	9.73	-32.45	35.14
DSGDP	Interest & Amortization on Total External Debt as a % of GDP	132	6.73	3.53	0.72	21.26
TDS	Debt Service Ratio (Total Debt)	132	0.29	0.16	0.04	0.81
DODGDP1	Long Term Debt as a Percentage of GDP	132	48.57	29.43	10.50	143.00
GASTIL	Level of Institutional Development	132	4.34	1.41	1.00	7.00
PCOM	Commitment to Poverty Alleviation	132	3.66	1.26	1.00	5.00
HDRPOOR	Human Development Report's Poverty Incidence	75	30.63	12.94	12.00	71.00
WBPOOR	World Development Report's Poverty Incidence	61	26.18	8.84	14.00	43.00
P2185	Ravallion's Poverty Incidence: $21/month in 1985 PPP	93	17.03	13.91	2.04	46.09
P3085	Ravallion's Poverty Incidence: $30.42/month in 1985 PPP	93	30.89	18.52	7.11	72.96
P6085	Ravallion's Poverty Incidence: $60/month in 1985 PPP	93	60.89	17.84	35.19	94.94
NFFCAP1K	Net Foreign Flows Inclusive of IMF Flows in 1980 US $	132	56.66	104.98	-377.20	771.47
NFFCAP2K	Net Foreign Flows Exclusive of IMF Flows in 1980 US $	132	52.19	98.83	-368.35	707.65
NOFGDP1	Net Official Flows Inclusive of IMF Flows as a % of GDP	132	2.73	2.65	-0.91	11.55
NOFGDP2	Net Official Flows Exclusive of IMF Flows as a % of GDP	132	2.32	2.03	-0.54	11.59
NCBGDP	Net Commercial Bank Flows as a % of GDP	132	0.80	1.74	-7.67	6.34
DFIGDP	Net Direct Foreign Investment Flows as a % of GDP	132	0.73	1.14	-1.52	5.21
Y80	Dummy Variable Set to 1 if Year is 1980	132	0.15	0.36	0.00	1.00
Y81	Dummy Variable Set to 1 if Year is 1981	132	0.14	0.34	0.00	1.00
Y82	Dummy Variable Set to 1 if Year is 1982	132	0.13	0.34	0.00	1.00
Y83	Dummy Variable Set to 1 if Year is 1983	132	0.14	0.34	0.00	1.00
Y84	Dummy Variable Set to 1 if Year is 1984	132	0.15	0.36	0.00	1.00
Y85	Dummy Variable Set to 1 if Year is 1985	132	0.15	0.36	0.00	1.00
Y86	Dummy Variable Set to 1 if Year is 1986	132	0.14	0.35	0.00	1.00

A frequency distribution of countries included in the base analysis by year is provided in Tables 4 and 5 for the central and consolidated budget analyses, respectively. As can be seen, the data series are incomplete for about 40 percent of the countries. In order to maximally exploit the available information, the base and sensitivity analyses are initially undertaken using OLS; that is, initially no correction for bias resulting from autocorrelation is undertaken. Note, even in the presence of autocorrelation, the OLS estimates of the coefficients are unbiased and consistent, although they are not efficient. With positive autocorrelation, the estimates of the coefficient variances are negatively biased implying that the calculated acceptance regions are narrower than they should be for the specified level of significance or confidence. This implies that the estimated significance levels are overestimates of the true significance levels. For the base sets of models, a test for autocorrelation is undertaken, using a method which corrects for autocorrelation. No evidence of autocorrelation is found, and differences between the corrected and uncorrected results are minimal. Accordingly, correction of the sensitivity analyses for autocorrelation was deemed unwarranted.

B. Determinants of Per Capita Central Budget Expenditures on Infrastructure

Appendix B presents the signs and significance levels of variables for all sensitivity analyses undertaken to isolate the determinants of per capita central budget expenditures on infrastructure without any correction for autocorrelation.[10] All of the regressions are highly significant with adjusted R^2s ranging from .70 to .84, but typically in the .78 to .81 range.[11]

All variables are consistently significant in the base runs, with the exception of the stock of infrastructure, the internal balance, the terms of trade shock and some of the variables capturing the mix of foreign savings. Several of these variables are sensitive to the exact definition of the variable. In addition, significance levels are generally low, or fluctuate across specifications for the variables assessing the impact of the external balance and debt obligations on per capita central budget expenditures on infrastructure.

1. The Stock of Infrastructure

Table B1 in Appendix B presents the signs and significance levels of variables for the alternative OLS base regressions. Four different bases are considered, differing by how the stock of infrastructure is measured. For each alternative base, five regressions are included. The first regression in each set (M1) excludes the influence of foreign savings from consideration altogether, while the second (M2) includes the influence of foreign savings but excludes any variable reflecting the mix of foreign savings from consideration. The last three regressions include a variable reflecting the mix of foreign savings. The third (M3) focuses on the influence of official savings flows, the fourth (M4) on the influence of commercial bank flows and the fifth (M5) on the influence of direct foreign investment.

Table 4. Central Budget Regressions: Number of Observations by Country

Country	Country	Number of Obs.
Bolivia	BOL	3
Brazil	BRA	5
Chile	CHL	7
Cameroon	CMR	6
Costa Rica	CRI	7
Egypt	EGY	7
Guatemala	GTM	7
India	IND	7
Kenya	KEN	7
South Korea	KOR	7
Liberia	LBR	7
Sri Lanka	LKA	7
Morocco	MAR	7
Mexico	MEX	7
Mauritius	MUS	7
Malaysia	MYS	7
Nigeria	NGA	2
Nicaragua	NIC	1
Pakistan	PAK	7
Panama	PAN	2
Peru	PER	7
Philippines	PHL	7
Thailand	THA	7
Turkey	TUR	4
Tanzania	TZA	3
Zimbabwe	ZWE	5

Table 5. Consolidated Budget Regressions: Number of Observations by Country

Country	Country Code	Number of Obs.
Bolivia	BOL	3
Brazil	BRA	5
Chile	CHL	7
Cameroon	CMR	6
Costa Rica	CRI	7
Egypt	EGY	7
Guatemala	GTM	3
Indonesia	IDN	7
India	IND	7
South Korea	KOR	7
Liberia	LBR	7
Sri Lanka	LKA	7
Morocco	MAR	7
Mexico	MEX	7
Mauritius	MUS	7
Malaysia	MYS	7
Nicaragua	NIC	1
Pakistan	PAK	7
Panama	PAN	2
Thailand	THA	7
Turkey	TUR	4
Tanzania	TZA	3
Zimbabwe	ZWE	7

The effect of the stock of infrastructure on per capita central budget infrastructure expenditures is sensitive to how the stock of infrastructure is measured. When infrastructure is measured narrowly as the kilometers of roads and rail, the coefficient is always positive, although not significantly so when the stock of roads and railways is measured relative to GDP per capita. In addition, when this stock is measured relative to the population size, the effect is nonlinear. The magnitude of the impact of the stock of infrastructure on per capita central government infrastructure expenditures is not insubstantial. A one kilometer increase in the stock of roads and rail per thousand square kilometers land area increases infrastructure expenditures by US 1980 $ 0.01 per capita. At the sample mean, this implies an elasticity of 0.23. (Unless otherwise noted, all elasticity estimates are based on model 2 (M2) in each regression set, the model including foreign funding flows, but excluding the breakdown by source of funding, and are calculated assuming the mean values of the independent variable of concern and the independent variable.) A one kilometer increase in the stock per US 1980 $ GDP increases per capita infrastructure expenditures by two to four tenths of a cent. Here the elasticity estimate at the sample mean is considerably lower, 0.03. The stock of infrastructure, measured as the number of kilometers of road plus rail per person, positively influences per capita central budget infrastructure expenditures until road plus rail kilometers per person reaches a value of .00715, about two times the sample mean value. The elasticity estimate at the sample mean is considerably larger, 0.29. When the stock of infrastructure is measured broadly as the total capital stock, the coefficient is negative, but never significantly so.

Overall, a conclusion that the stock of infrastructure increases per capita central government infrastructure expenditures by a sizable amount appears warranted. The impact of expenditures needed to offset depreciation of the existing infrastructure stock and/or complementarity between infrastructure and the structure of the economy, more than fully offsets the effect of diminishing returns to infrastructure expenditures.

The significance of other variables as determinants of per capita infrastructure expenditure is quite robust across the alternative bases. Among the alternative bases, a narrow definition of infrastructure appears to more faithfully track the total public infrastructure stock. Among the three alternative narrow definitions of infrastructure, the definition of infrastructure stock as the total kilometers of road and rail per 1000 square kilometers land area, FCINFPA, performs marginally better overall and, accordingly, is used as the base for the sensitivity analyses. The full results of the five regressions (M1 through M5) using this narrow definition of the stock of infrastructure are shown in Table 6. The results in Table 6 do not include any correction for autocorrelation.

Before proceeding further, a test for autocorrelation is in order. The results of simple autocorrelation tests from the OLS estimates are inappropriate, given the pooled cross-section, time-series nature of the data set. One means of ensuring coefficient estimates are efficient as well as unbiased is to include in the regressions dummy variables for the year of the observation. An appropriate test for autocorrelation is then to test whether the year dummies are jointly significant by means of an F test. Table 7 shows the results of the same base set of regressions including a set of dummy variables for year. Here Y81 is set equal to 1 if the observation is from 1981, but zero otherwise; Y82 is set equal to 1 if the observation is from 1982, but zero otherwise, and so on. The omitted year is 1980. The formula for computing the F value for the joint significance test is $[(R^2_Q - R^2_K)/(1 - R^2_Q)]/[(n-Q)/(Q-K)]$ where Q and K are the number of regressors in the expanded and original regressions (including the intercept), respectively, and n is the number of observations. The resultant F values for the five models are 0.97, 0.53, 0.62, 0.38 and 0.63, respectively. The critical $F_{Q-K,n-Q}$ value at the 20 percent significance level is greater than 1.40 in all cases. There is no evidence of autocorrelation. Further, the coefficient magnitudes are quite comparable between estimates, as are significance levels for the independent variables, although TBWTGDPL and DSGDP increase somewhat in significance, while NFFCAP1K decreases somewhat in significance. In view of the absence of any evidence of bias from autocorrelation, no correction for autocorrelation is required, and the sensitivity analyses are undertaken excluding any control for the year of observation.

Table 6. Central Budget Base Infrastructure Regressions

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
INTERCEPT	25.80** (2.35)	24.17** (2.25)	26.04** (2.38)	34.32** (3.08)	26.28** (2.45)
FCINFPA	1.04E-2** (2.33)	1.06E-2** (2.43)	1.12E-2** (2.53)	1.08E-2** (2.52)	1.13E-2*** (2.65)
GDPCAPK	3.53E-2*** (6.62)	3.62E-2*** (6.93)	3.48E-2*** (6.38)	3.34E-2*** (6.43)	3.52E-2*** (6.92)
GDPCPKSQ	-3.66E-6** (-2.29)	-4.23E-6*** (-2.68)	-4.05E-6** (-2.54)	-3.53E-6** (-2.26)	3.86E-6** (-2.50)
DENS	1.13E-1*** (4.09)	1.14E-1*** (4.20)	1.05E-1*** (3.69)	9.97E-2*** (3.70)	1.07E-2*** (4.02)
DENSSQ	-3.58E-4*** (-6.55)	-3.52E-4*** (-6.59)	-3.38E-4*** (-6.09)	-3.18E-4*** (-5.94)	-3.30E-4*** (-6.31)
URBAN4	-4.72E-1*** (-5.96)	-4.63E-1*** (-5.97)	-4.52E-1*** (-5.77)	-5.47E-1*** (-6.69)	-4.95E-1*** (-6.44)
MIGZ	4.54*** (5.77)	4.55*** (5.91)	4.51*** (5.86)	4.45*** (5.91)	4.26*** (5.60)
LFPER	-1.35*** (-6.95)	-1.32*** (-6.98)	-1.33*** (-7.02)	-1.43*** (-7.56)	-1.28*** (-6.89)
BBGDPL	-2.07E-1 (-1.24)	-2.37E-1 (-1.46)	-2.35E-1 (-1.44)	-1.76E-1 (-1.10)	-1.39E-1 (-0.86)
TVALX2	52.79*** (6.41)	48.96*** (5.99)	52.67*** (5.78)	45.81*** (5.68)	37.55*** (4.05)
TBWTGDPL	2.05E-1* (1.71)	2.28E-1* (1.94)	2.04E-1* (1.70)	3.31E-1*** (2.74)	1.68E-1 (1.42)
TOTS	-1.09E-1 (-1.56)	-8.92E-2 (-1.31)	-9.12E-2 (-1.33)	-1.08E-1 (-1.61)	-1.06E-1 (-1.58)
TOTSSQ	-5.58E-3** (-2.10)	-4.79E-3* (-1.83)	-4.62E-3* (-1.76)	-4.36E-3* (-1.71)	-4.24E-3 (-1.64)
DSGDP	5.62E-1** (2.36)	3.59E-1 (1.47)	3.60E-1 (1.47)	7.07E-1** (2.61)	5.79E-1** (2.33)

Table 6 (Con't). Central Budget Base Infrastructure Regressions

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
GASTIL	-2.69*** (-4.27)	-2.52*** (-4.08)	-2.47*** (-4.00)	-2.52*** (-4.19)	-2.58*** (-4.30)
PCOM	7.71** (2.29)	8.09** (2.45)	7.70** (2.31)	6.49** (1.98)	8.49** (2.53)
PCOMSQ	-1.07** (-2.08)	-1.14** (-2.26)	-1.08** (-2.13)	-8.65E-1* (-1.72)	-1.23** (-2.37)
NFFCAP1K	-	2.03E-2*** (2.67)	2.30E-2*** (2.82)	1.39E-2* (1.78)	2.08E-2*** (2.66)
NOFGDP1	-	-	-3.37E-1 (-0.92)	-	-
NCBGDP	-	-	-	1.29*** (2.73)	-
DFIGDP	-	-	-	-	-3.12** (-2.10)
DFIGDPSQ	-	-	-	-	1.10*** (3.02)
R^2	0.8097	0.8195	0.8207	0.8293	0.8323
Adjusted R^2	0.7852	0.7947	0.7945	0.8044	0.8063
F- Value	33.042	33.050	31.319	33.240	32.010
N	150	150	150	150	150

*** Significant at .01 level or better
** Significant at .05 level or better
* Significant at .10 level or better

Table 7. Central Budget Infrastructure Regressions with Time Dummies

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
INTERCEPT	27.33** (2.45)	25.90** (2.34)	28.49** (2.54)	35.59*** (3.10)	28.18** (2.57)
FCINFPA	1.16E-2** (2.57)	1.13E-2** (2.53)	1.23E-2*** (2.71)	1.13E-2** (2.58)	1.22E-2*** (2.81)
GDPCAPK	3.49E-2*** (6.50)	3.57E-2*** (6.71)	3.37E-2*** (6.05)	3.31E-2*** (6.23)	3.50E-2*** (6.76)
GDPCPKSQ	-3.64E-6** (-2.26)	-4.12E-6** (-2.56)	-3.84E-6** (-2.37)	-3.46E-6** (-2.16)	-3.80E-6** (-2.42)
DENS	1.17E-1*** (4.18)	1.15E-1*** (4.18)	1.05E-1*** (3.63)	1.01E-1*** (3.67)	1.10E-1*** (4.07)
DENSSQ	-3.65E-4*** (-6.63)	-3.57E-4*** (-6.53)	-3.40E-4*** (-6.05)	-3.23E-4*** (-5.85)	-3.37E-4*** (-6.32)
URBAN4	-4.80E-1*** (-6.03)	-4.71E-1*** (-5.99)	-4.57E-1*** (-5.75)	-5.50E-1*** (-6.60)	-5.07E-1*** (-6.51)
MIGZ	4.47*** (5.62)	4.47*** (5.69)	4.43*** (5.65)	4.38*** (5.69)	4.18*** (5.39)
LFPER	-1.35*** (-6.93)	-1.33*** (-6.88)	-1.34*** (-6.96)	-1.43*** (-7.39)	-1.27*** (-6.77)
BBGDPL	-2.31E-1 (-1.32)	-2.55E-1 (-1.47)	-2.53E-1 (-1.46)	-1.89E-1 (-1.09)	-1.73E-1 (-1.01)
TVALX2	49.64*** (5.69)	47.29*** (5.44)	52.29*** (5.45)	44.53*** (5.18)	33.80*** (3.34)
TBWTGDPL	3.26E-1** (2.39)	3.03E-1** (2.24)	2.89E-1** (2.14)	3.81E-1*** (2.80)	2.53E-1* (1.90)
TOTS	-1.14E-1 (-1.53)	-1.00E-1 (-1.37)	-1.01E-1 (-1.38)	-1.18E-1 (-1.63)	-1.16E-1 (-1.61)
TOTSSQ	-5.20E-3* (-1.71)	-5.22E-3* (-1.74)	-4.62E-3 (-1.52)	-4.88E-3* (-1.66)	-4.60E-3 (-1.55)
DSGDP	7.02E-1*** (2.71)	5.01E-1* (1.83)	5.28E-1* (1.92)	8.07E-1*** (2.73)	7.79E-1*** (2.78)

Table 7 (Con't). Central Budget Infrastructure Regressions with Time Dummies

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
GASTIL	-2.61***	-2.47***	-2.42***	-2.48***	-2.50***
	(-4.08)	(-3.89)	(-3.81)	(-3.98)	(-4.05)
PCOM	7.57**	7.72**	7.27**	6.21*	8.31**
	(2.22)	(2.29)	(2.15)	(1.85)	(2.42)
PCOMSQ	-1.03*	-1.07**	-1.00*	-8.11E-1	-1.19**
	(-1.98)	(-2.07)	(-1.93)	(-1.57)	(-2.24)
NFFCAP1K	-	-1.72E-2**	1.96E-2**	1.17E-2	1.73E-2**
		(2.04)	(2.28)	(1.38)	(2.05)
NOFGDP1	-	-	-4.72E-1	-	-
			(-1.21)		
NCBGDP	-	-	-	1.22**	-
				(2.49)	
DFIGDP	-	-	-	-	-3.23**
					(-2.14)
DFIGDPSQ	-	-	-	-	1.15***
					(3.08)
Y81	-9.31E-1	-1.28	-1.01	-1.42	-2.11
	(-0.39)	(-0.54)	(-0.42)	(-0.61)	(-0.91)
Y82	1.03	7.93E-1	1.02	2.63E-2	-5.18E-1
	(0.42)	(0.32)	(0.42)	(0.01)	(-0.21)
Y83	-2.97E-1	-7.17E-1	-5.74E-1	-6.10E-1	-2.10
	(-0.11)	(-0.28)	(-0.22)	(-0.24)	(-0.81)
Y84	-2.39	-2.13	-2.16	-2.27	-2.72
	(-0.96)	(-0.86)	(-0.87)	(-0.94)	(-1.13)
Y85	-4.33	-3.33	-3.70	-2.93	-4.42*
	(-1.65)	(-1.26)	(-1.39)	(-1.13)	(-1.70)
Y86	-2.88	-1.48	-2.17	-1.39	-2.89
	(-1.07)	(-0.54)	(-0.78)	(-0.51)	(-1.07)
R^2	0.8181	0.8240	0.8260	0.8324	0.8373
Adjusted R^2	0.7849	0.7902	0.7910	0.7986	0.8029
F-Value	24.637	24.380	23.553	24.627	24.342
N	150	150	150	150	150

*** Significant at .01 level or better
** Significant at .05 level or better
* Significant at .10 level or better

2. *Population Density*

Population density is highly significant in all regressions. Significance levels show little variation across all base regressions, as can be seen in Table B1 in Appendix B. It is highly significant, generally at the 1 percent level, in all sensitivity analyses except when per capita GDP is measured in purchasing power parity dollars and when poverty incidence variables replace the poverty commitment variable, as can be seen from the other tables in Appendix B. Population density positively influences per capita central budget infrastructure expenditures, but the effect is nonlinear. The estimated sign suggests that economies of scale induce a higher level of infrastructure provision in more densely populated countries or that certain types of infrastructure expenditures become more necessary in the context of high population densities.

The impact of population density is substantial as can be seen from Table 6. In the base regression using FCINFPA and including the total flow of foreign savings per capita, the impact of population density is found to increase per capita expenditures until the population density reaches a value of 161, about one and a half times the mean population density in the sample. At the mean population density, population density independently accounts for (1980) US $ 8.05 of the total per capita central budget infrastructure expenditures and implies an elasticity of 0.24 when per capita infrastructure expenditures are at their mean value. The size of the estimated impact is somewhat greater in the alternative base regressions, and sometimes smaller in some of the sensitivity analyses.

3. *Urbanization*

Urbanization is a significant determinant of central budget infrastructure expenditures. It is significant at the 1 percent level or better in all estimates, with the exception of the estimates replacing PCOM with indicators of poverty incidence, as can be seen from the tables in Appendix B.

Urbanization reduces per capita central budget infrastructure expenditures, *ceteris paribus*, as hypothesized. The effect of urbanization is substantial. The coefficient range is reasonably stable across all sensitivity analyses. A one percentage point increase in the urbanization rate reduces per capita central budget expenditures on infrastructure by approximately (1980) US $ 0.50. At the sample means for urbanization level and per capita infrastructure expenditures, this implies an elasticity of -1.1.

4. *Sectoral Balance*

The greater the imbalance between rural and urban sectors, the higher are per capita central budget expenditures on infrastructure, as hypothesized. The coefficient for the rural-urban migration rate, MIGZ, is positive and highly significant in all base regressions (1 percent level or better). It is positive and highly significant in all sensitivity analyses with the exception of the regressions replacing poverty commitment with poverty incidence, which as will be discussed later, appears to lead to specification error.

The magnitude of the impact is sizable. When the migration rate increases by one percentage point, per capita central budget expenditures on infrastructure increase by approximately (1980) US $ 4.50, as can be seen from Tables 6 and 7. The implied elasticity at the sample mean migration rate and per capita infrastructure expenditure level is 0.41. The sensitivity analyses indicate some variation in the estimated magnitude of the effect. With few exceptions, however, the range of estimates falls between (1980) US $ 4.00 and US $ 5.00.

This finding is, however, sensitive to how the sectoral balance is measured as can be seen from Table B2 in Appendix B. Both the share of GDP in the agricultural sector, SAGR4, and the level of agricultural income per capita, AGCAPK, positively influence the per capita infrastructure expenditures. Holding per capita GDP and urbanization constant, higher values of these variables should reflect greater sectoral balance. However, because as the level of development increases the share of income earned in rural areas from agricultural activities tends to decrease, and because neither variable accounts for differences in social service provision between rural and urban areas, these proxies for rural welfare are not likely to measure differences between rural and urban welfare as accurately as migration rates.

5. Labor Force Participation Rate

The greater the labor force participation rate, the lower is per capita central budget infrastructure expenditure. LFPER is without exception significant at the 1 percent level. The strong (and robust) negative relationship found indicates that labor and infrastructure are net substitutes and/or that more rapid population growth induces higher per capita expenditure on infrastructure, other factors (including per capita GDP) held constant. Note that the *ceteris paribus* condition is important in making sense of this result. It implies, for example, that countries with low labor force participation rates (high population growth rates) can achieve comparable per capita GDP levels by substituting public infrastructure for labor.

The magnitude of the impact of the labor force participation rate is substantial as can be seen from Tables 6 and 7. A one percentage point increase in the labor force participation rate reduces per capita central government expenditures on infrastructure by about (1980) US $ 1.30, implying an elasticity of -2.73 at the sample mean values for LFPER and BTACCAPK. The magnitude of the estimated impact is somewhat greater when the stock of infrastructure is measured relative to the size of the population and somewhat lower when the stock is measured as the total capital stock. While there is some variation in the estimated magnitude of the effect across sensitivity analyses, the range of estimates is generally between (1980) US $1.20 and $1.50. The elasticity estimates are always very large, and range between -2.5 and -3.1.

6. Level of Development

The level of GDP per capita positively influences per capita infrastructure expenditures, as hypothesized. However, the effect is nonlinear. The estimated coefficient levels are highly significant (generally at the 1 percent level for the linear term and the 5 percent level for the negative quadratic term) in all regressions measuring level of development as GDPCAPK. In addition, the variation in the size of the estimated coefficients is quite small across all regressions. The estimated coefficients for the base FCINFPA regression including total foreign savings flows (Table 6, M2) indicate that for per capita GDP levels below (1980) US $ 4282, increases in per capita GDP increase per capita central budget expenditures on infrastructure. At the sample mean values of GDPCAPK and BTACCAPK, the elasticity is 1.69, indicating per capita infrastructure expenditures respond more than proportionately to increases in per capita GDP.

Whether or not the effect of GDP per capita increases is nonlinear is sensitive to how per capita GDP is measured. When measured in 1985 PPP dollars, the quadratic term fails to reach significance, as can be seen in Table B3 in Appendix B. The estimated coefficient for the linear term indicates that for each $100 increase in per capita income measured in 1985 PPP dollars, central budget expenditures on infrastructure increase by about (1980) US $ 1.50, implying an elasticity of 1.57 at the sample mean values for GDPCAP2 and BTACCAPK.

7. Internal Balance

Evidence that governments respond to fiscal crises by scaling back central government expenditures on infrastructure is mixed. The sign of the coefficient for BBGDPL is consistently negative (contradicting this hypothesis), as can be seen in Tables 6 and 7 and all tables in Appendix B. However, in the base regressions (Tables 6 and 7) and sensitivity analyses for the stock of infrastructure (Table B1 in Appendix B) BBGDPL is never significant at the 10 percent level, and seldom reaches significance at the 15 percent level. Tables B3 and B5 through B7 in Appendix B also suggest central government infrastructure expenditures may be protected, even in the context of high government budget deficits. The lack of response may also be due to the long planning periods and bonding procedures inherent in infrastructure investments. That is, this year's expenditures on infrastructure are unlikely to be influenced by recent fiscal pressures. Whether or not infrastructure expenditures several years in the future are likely to be negatively impacted by current budget deficits is a question which merits exploration.

Several of the sensitivity analyses lend stronger support to contentions that infrastructure expenditures are sensitive to fiscal crises. However, the evidence indicates higher budget deficits are associated with higher, rather than lower, infrastructure expenditure. The sensitivity analyses exploring the effect of alternative indicators of sectoral imbalance (Table B2 in Appendix B) indicate a negative relationship between BBGDPL and central budget per capita infrastructure expenditures, significant at the 10 to 15 percent level, as do sensitivity analyses exploring the impact of poverty on infrastructure expenditures (Table B8 in Appendix B).

The opposite conclusion is reached when inflation is used as an indicator of the degree of internal balance, as Table B4 in Appendix B indicate. A significantly negative, but nonlinear effect is found bottoming out only when the inflation rate reaches about 230 percent. It may be that what is more important than the actual size of the budget deficit is the extent to which the deficit is financed in a sustainable manner; the inflation rate is a more accurate indicator of internal imbalance in this respect. Significance levels remain low (never reaching the 5 percent level), however. Further, the estimated impact is not as large as might be expected. At the sample mean inflation rate and per capita central budget infrastructure expenditure level, the elasticity is only -0.12.

8. External Balance

There is some evidence that the external balance modestly influences per capita central budget expenditures on infrastructure. As can be seen in Tables 6 and 7 and Appendix B, although significance levels are low (generally only 10 percent level), a better external balance exerts a positive influence on infrastructure expenditures. Significance levels are generally highest in regressions accounting for the importance of commercial bank flows in total foreign savings flows and lowest in regressions accounting for the importance of direct foreign investment in total foreign savings flows.

The magnitude of the estimated impact varies somewhat across specifications, although it is never large. In the FCINFPA base regressions including total foreign savings alone, the estimated coefficient implies an increase in per capita central government expenditures ranging from (1980) US $ 0.23 (Table 6) to $ 0.30 (Table 7) for every percentage point increase in TBWTGDPL. The estimated impact increases to (1980) US $ 0.33 and $ 0.38 in Tables 6 and 7, respectively, when the magnitude of commercial bank flows are included, but decreases to (1980) US $ 0.17 and $ 0.25 in Tables 6 and 7, respectively, when the relative importance of direct foreign investment is included. The estimated impact is about half the above amounts in the base regressions using FCINFPP and FCINFGDP. It is uniformly somewhat higher when level of development is measured in purchasing power parity terms (GDPCAP2).

One's conclusion concerning the importance of the external balance for infrastructure expenditures is also sensitive to how the external balance is measured, as can be seen from Table B5 in Appendix B. When the trade balance is measured as the black market foreign exchange premium, significance levels are somewhat greater. Still, the estimated impact is small with a 1 percentage point increase in the black market foreign exchange premium leading to only about a (1980) US $ 0.02 decrease in per capita central government infrastructure expenditures. When the external balance is measured as DOLLAR4, no significant impact is found.

Overall, the external balance does not appear to be an important determinant of per capita central budget expenditures on infrastructure. The opposing forces at work appear to more or less offset each other.

9. Size of Foreign Sector

There is strong evidence that countries with large foreign sectors allocate significantly more to infrastructure expenditures, as hypothesized. TVALX2 is significantly positive in all regressions, as can be seen from Tables 6 and 7 and Appendix B. With very few exceptions, the estimated coefficient is significant at better than the 1 percent level. The estimated magnitude of the impact is also sizable. A one percentage point increase in exports plus imports as a percentage of GDP leads to approximately a (1980) US $ 0.50 increase in per capita central government expenditures on infrastructure, implying an elasticity of 0.60 at the sample means of TVALX2 and BTACCAPK. The precise magnitude of the estimated impact varies somewhat across model specifications, although, in general, the magnitudes are comparable.

10. Terms of Trade Shocks

The estimated impact of a terms of trade shock on infrastructure expenditures is not as hypothesized. Rather than a strictly positive relationship, an inverted U relationship between changes in the terms of trade and central government expenditures on infrastructure is found. As can be seen from Tables 6 and 7 and Appendix B, the signs of both the linear and quadratic terms are always negative. Infrastructure investments are greatest when the deterioration in the terms of trade is about 9 percent. Infrastructure expenditures decrease when the terms of trade deteriorate by a greater amount or an improvement in the terms of trade is experienced. Governments appear to respond to fairly modest deteriorations in the terms of trade, by increasing infrastructure investments, perhaps in an effort to increase profit margins and stimulate export levels so as to maintain foreign exchange earnings. When the terms of trade deteriorate by a substantial amount, however, this approach is either viewed as inadequate to maintain foreign exchange earnings, or infeasible, given decreases in tax revenues. Improvements in the terms of trade lead to reduced infrastructure expenditures; perhaps because profit margins and foreign exchange earnings are viewed as adequate, easing the pressure to improve existing infrastructure.

Significance levels of the estimated coefficients are, however, low. The linear term is only significant at the 15 percent level, at best, while the quadratic term is typically only significant at the 10 percent level. Even if taken as significant, the estimated coefficients indicate the impact of terms of trade shocks is small. The estimated coefficient in Table 6, including the total savings flow alone, indicates that at the sample mean a one percentage point improvement in the terms of trade (from a negative value of -2.31 to -1.31) would only decrease per capita central budget infrastructure expenditures by (1980) US $ 0.07. The estimated elasticity at the sample mean is only 0.01. This relative lack of sensitivity could also reflect the long planning periods for infrastructure investments.

11. Debt Obligations

Contrary to expectations, the results indicate that central budget infrastructure expenditures are insulated from cuts induced by debt service obligations. In fact, the evidence indicates larger debt service obligations induce slightly greater infrastructure expenditures, especially when commercial bank loans and direct foreign investment are relatively large components in current foreign savings flows. Both the significance level and the estimated magnitude of the impact are greater in the regressions including the size of current net resource flows from foreign commercial banks and the magnitude of direct foreign investment relative to GDP, as can be seen in Tables 6, 7, B1, B2, B3, B4, B5 and B7. Table 6 indicates that when direct foreign investment as a percentage of GDP is included in the regression, the estimated coefficient for DSGDP indicates that for every one percentage point increase in debt service relative to GDP, central budget per capita infrastructure expenditures increase by (1980) US $ 0.58. This figure increases to (1980) US $ 0.70 when net commercial bank flows as a percentage of GDP are included in the regression. The corresponding elasticity values at the sample mean values of DSGDP and BTACCAPK are 0.22 and 0.27. (All figures calculated on the basis of the FCINFPA base regressions.)

This finding is not fully robust. Significance levels are low and frequently fail to reach the 15 percent level when the total magnitude of foreign savings alone or the relative magnitude of official net transfers, relative to GDP are included in the regressions. In the regressions considering alternative measures of sectoral balance (B2), the coefficient on DSGDP is only significant when foreign flows are entirely excluded from the regression or the importance of commercial bank flows is included. It is seldom significant with the alternative poverty indicators are included in the regression (Table B8). Further, findings are sensitive to how debt service obligations are measured. As Table B6 shows, if debt obligations are measured as the debt service ratio (TDS), the coefficients on TDS are insignificant in the regressions including total net transfers alone and the magnitude of official transfers. Further, if debt obligations are measured as the total long term debt as a percentage of GDP (DODGDP1), the estimated coefficients are negative and insignificant in all five regressions.

12. Institutional Development

The level of institutional development is a significant and important determinant of per capita central budget expenditures on infrastructure. The coefficient for GASTIL is negative indicating that the greater the degree of institutional development, the greater are expenditures on infrastructure. Significance levels are, with very few exceptions, at the one percent level or better. The only contrary evidence occurs when the alternative measures of sectoral balance are used or when incidence of poverty measures are substituted for poverty commitment. In both these cases, however, the substitutions appear to result in specification bias.

The estimated sign of the coefficient in the base regression sets (Tables 6 & 7) indicates that a one unit increase in the value of GASTIL (indicating poorer institutional development) results in approximately a (1980) US $ 2.50 decrease in per capita central budget expenditures. The implied elasticity at the sample mean values for GASTIL and BTACCAPK is just over -0.60. There is some variation in the estimated magnitude of the impact across specifications. Excluding the anomalous cases mentioned above, the estimated impact of a one unit increase in the value of GASTIL is between (1980) US$-2.00 and US$-3.50.

13. Level and Mix of External Funding

Central budget per capita infrastructure expenditures are positively associated with foreign savings flows.[12] In all regressions including net per capita savings flows alone, NFFCAP1K has a positive coefficient which, with few exceptions, is significant at the 1 percent level, as can be seen from Tables 6 and 7 and Appendix B. External funding remains a significantly positive determinant of central budget per capita infrastructure expenditures regardless of whether or not IMF credit is included in the tally of foreign savings flows, as can be seen from Table B7. The estimated magnitude of the impact is, however, quite small and amounts to only (1980) US $ 0.02 for every (1980) US $1.00 increase in net per capita foreign savings. At the sample mean values of NFFCAP1K and BTACCAPK the elasticity is 0.06. The estimated magnitude of the impact is surprisingly stable across all sensitivity analyses.

The mix of foreign funding influences infrastructure expenditures. In particular, holding the total magnitude of foreign funding constant, commercial bank flows induce increased infrastructure expenditures, while, contrary to expectations, the relationship between direct foreign investment and per capita central budget infrastructure expenditures is U shaped. Infrastructure expenditures fall with increases in direct foreign investment until the level of direct foreign investment reaches about 1.4 percent of GDP; per capita infrastructure investment only increases with increases in direct foreign investment in countries where the level of direct foreign investment is about one standard deviation above the mean sample value. Countries receiving a high percentage of foreign savings as official transfers do not spend any more or less on infrastructure than other countries receiving the same magnitude of total foreign funding. Again, this latter finding is insensitive to whether official flows are defined to include or exclude IMF credit, as can be seen from Table B7.

14. Government Objectives -- Poverty Commitment

The results indicate that a government's commitment to poverty alleviation influences per capita central government infrastructure expenditures. The effect follows an inverted-U pattern. Initially as commitment to poverty alleviation increases, per capita central budget expenditures on infrastructure increase as well. Once the level of commitment to poverty alleviation reaches a certain threshold, however, a further increase in commitment leads to decreased expenditures on infrastructure. This suggests that governments with some, but limited, commitment to poverty alleviation adopt strategies focused on increasing the poor's productivity through infrastructure investments, but that as the commitment to poverty alleviation intensifies the strategy shifts to one either fostering the poor's human capital accumulation or emphasizing the provision of a social safety net and that funding for these strategies competes with funding for infrastructure provision.

This finding is quite robust. As Tables 6, 7 and B1 show, both the linear and quadratic terms are with few exceptions significant at the 5 percent level or better in all base regressions, except when the total capital stock is used to proxy for the stock of infrastructure. In this case both variables only reach significance at the 15 percent level. The result extends across sensitivity analyses. As can be seen in Tables B2 through B7, both the linear and quadratic poverty commitment terms are significant at the 5 percent level or better. The only exception occurs when the level of development is measured in purchasing power parity terms (GDPCP2); in this case, PCOM and PCOMSQ are insignificant, but carry the appropriate signs. Peak expenditures on infrastructure occur when the degree of poverty commitment is close to the sample mean. Based on the regression measuring infrastructure stocks as road and rail kilometers per 100 square kilometers land area and including total foreign funds alone (Table 6, M2), the peak contribution to per capita central budget infrastructure expenditures occurs when PCOM equals 3.55, while the sample mean value of PCOM is 3.44. The effect is also substantial. When PCOM equals 3.55, it independently accounts for US 1980 $ 14.36 of total per capita central budget expenditures on infrastructure. In countries where there is overwhelming evidence of a strong and credible commitment to poverty alleviation (PCOM=5) and where there is no evidence of any commitment to poverty alleviation (PCOM=1), the comparable figures are US 1980 $ 12.00 and $ 6.00, respectively.

A comparison of the regressions including and excluding PCOM from the regression provides further evidence of the influence of a country's commitment to poverty alleviation on central budget infrastructure expenditures. As Table B8 shows, when poverty commitment is excluded from the regressions, the adjusted R^2 falls and the significance levels of some variables change. In particular, the quadratic term on level of development (GDPCPKSQ) becomes insignificant and its sign changes. The external balance variable (TBWTGDPL) also becomes insignificant, although in this case it carries the correct sign. The significance levels of several other variables change; the debt burden variable (DSGDP) becomes less significant, while the effect of terms or trade shocks is more significant, and, holding total foreign funding flows constant, official foreign funding flows negatively influence central budget per capita infrastructure expenditures. The changes in the adjusted R^2 and significance levels along with differences in the coefficient estimates suggest the model is misspecified when poverty commitment is excluded from the regression.

The regressions in Table B8 replacing poverty commitment with poverty levels indicate it is commitment to poverty alleviation, rather than the poverty level that matters. Despite the fact that all of the poverty measures are positively and significantly correlated (see Table 1), the effect of the poverty level on infrastructure expenditures differs depending upon the poverty measure used. When the United Nations Development Program's poverty line is used to measure poverty, a significant inverted U relationship is found which peaks at a poverty incidence of about 17 percent (about one half the sample mean incidence). However, when any of the other estimates of the incidence of poverty are substituted for PCOM in the regressions, none of the poverty coefficient estimates is significantly different from zero. Further, the signs of the estimated coefficients are unstable. For WBPOOR and P2085, the coefficient signs indicate an inverted U relationship, while for P3085 and P6085, a U shaped relationship is implied. Finally, when any of the measures of poverty incidence is substituted for poverty commitment, the significance levels of the other regressors are affected as are the coefficient magnitudes; just which coefficient estimates are affected differs across the alternative measures of poverty. These results indicate that estimates of the incidence of poverty cannot be used as a proxy for a government's commitment to poverty alleviation.

Government objectives do influence infrastructure expenditures as the results for poverty commitment show. Appropriate indices of government objectives need to be developed to fully explain expenditure patterns. Further work to define and refine indicators along the lines of our PCOM variable are warranted.

15. Central Budget Per Capita Infrastructure Expenditures: Summary and Conclusions

Table 8 summarizes the overall results of the analysis. The table shows the hypothesized relationship between the different variables and per capita central government expenditures, and the direction of the estimated relationship. The instantaneous rate of change in infrastructure expenditures and the elasticity are shown as computed for the sample mean values of the independent and dependent variables. In the case of nonlinear relationships, the estimated peak or trough is indicated. The values without parentheses are those corresponding to Table 6's FCINFPA base regression including foreign funding, M2, (and, except where relevant, excluding the mix of foreign funding), while the values in parentheses are those corresponding to the comparable regression including the dummy variables for year (Table 7).

Table 8. Central Budget Infrastructure Expenditures Summary Overall Results

Variable	Hypothesized Relationship	Estimated Relationship	Instantaneous Effect Effect 1 unit Increase	Peak or Trough	Elasticity at Mean
Stock of Infrastructure					
FCINFPA	?	>0	$ 0.01 ($ 0.01)	–	0.23 (0.16)
Population Density					
DENS & DENSSQ	?	Inverted U	$ 0.04 ($ 0.04)	161 (162)	0.24 (0.24)
Urbanization					
URBAN4	<0	<0	$-0.46 ($-0.47)	–	-1.10 (-1.12)
Sectoral Imbalance					
MIGZ	>0	>0	$4.55 ($4.47)	–	0.41 (0.40)
Labor Force Participation					
LFPER	?	<0	$-1.32 ($-1.33)	–	-2.73 (-2.73)
Level of Development					
GDPCAPK & GDPCPKSQ	>0 /Inverted U	Inverted U	$0.26 ($0.26)	$4282 (4340)	1.69 (1.68)
Internal Balance					
BBGDPL	?	N.S.	–	–	–
INFL4 & INFL4SQ	?	U Shaped	$-0.09	230	-0.12
External Balance					
TBWTGDPL	?	>0	$ 0.23 ($ 0.30)	–	-0.05 (-0.07)
BLACK	?	<0	$-0.02	–	-0.04
DOLLAR4	?	N.S.	–	–	–
Size Foreign Sector					
TVALX2	>0	>0	$ 48.96 ($ 47.29)	–	0.60 (0.58)
Terms of Trade Shock					
TOTS & TOTSSQ	>0	Inverted U	$-0.07 ($-0.08)	-9.31 (-9.64)	0.01 (0.01)
Debt Obligations					
DSGDP	<0	>0	$ 0.36 ($ 0.50)	–	0.13 0.19
Institutional Development					
GASTIL	?	<0	$-2.52 ($-2.47)	–	-0.62 (-0.61)
Level Foreign Funding					
NFFCAP1K	>0	>0	$ 0.02 ($ 0.02)	–	0.06 (0.05)
Mix of Foreign Funding					
NOFGDP1	?	N.S.	–	–	–
NCBGDP1	?	>0	$ 1.29 ($ 1.22)	–	0.06 (0.06)
DFIGDP & DFIGDPSQ	>0	U Shaped	$-1.60 ($-1.64)	$1.42 ($1.40)	-0.06 (-0.06)
Poverty Commitment					
PCOM & PCOMSQ	?	Inverted U	$ 0.25 ($ 0.38)	3.55 (3.62)	0.05 (0.07)

Among all of the factors hypothesized to potentially influence per capita central budgetary infrastructure expenditures, only two are found to have no influence. First, holding the level of foreign funding constant, official transfers neither increase nor decrease central budget per capita infrastructure expenditures. This finding is robust across all models and sensitivity analyses. Second, the internal balance, as measured by the budget balance as a percentage of GDP lagged one year, has no influence on current infrastructure expenditures. This result suggests that any tendency to postpone infrastructure investments in the context of high budget deficits is offset by a conscious policy fostering infrastructure investment or an inability to reduce budgetary allocations for infrastructure. The explanation for this latter possibility may be the long gestation period between the planning and implementation phase for infrastructure investments and bonding practices which effectively protect infrastructure expenditures. The finding that the internal balance has no influence on current infrastructure expenditures is not, however, robust. If the internal balance is measured by the rate of inflation, infrastructure expenditures are found to fall (at a decreasing rate) as the budget balance deteriorates. This suggests that infrastructure expenditures are not fully protected, despite bonding practices; when the budget deficit becomes unsustainable and governments increasingly have to resort to printing money to finance their deficit, infrastructure expenditures become a target of budget cuts.

For many of the variables hypothesized to influence per capita infrastructure expenditures (stock of infrastructure, population density, labor force participation rate, internal balance, external balance, institutional development, official flows, commercial bank flows and poverty commitment), no *a priori* hypothesis concerning the direction of the relationship could be made, given the opposing forces at work. However, for eight variables (urbanization, urban-rural imbalance, level of development, size of foreign sector, terms of trade shift, debt obligations, level of foreign funding and direct foreign investment), *a priori* hypotheses could be made. The estimated results fully bear out the hypotheses in the case of five variables (urbanization, level of development, urban-rural balance, size of the foreign sector, level of foreign funding), only partially bear out the hypotheses in the case of two variables (terms of trade shifts and direct foreign investment), and contradict the hypothesis in the case of one variable (debt obligations).

The negative relationship hypothesized and found between the urbanization rate and per capita central government infrastructure expenditures is highly significant and robust across models and sensitivity analyses. A positive or inverted U relationship between the level of development and per capita infrastructure expenditures was hypothesized and is substantiated. When the level of development across countries is compared on the basis of exchange rate conversions (GDPCAPK) and in constant 1980 dollars, a highly significant inverted U relationship is found, peaking at approximately US 1980 $ 4300. However, when purchasing power parity conversions are used (GDPCAP2), more accurately reflecting differences in standards of living across countries, a strictly positive linear relationship is found. The hypothesized positive relationship between the extent of the urban-rural imbalance, size of the foreign sector, and level of foreign funding on the one hand and per capita infrastructure expenditures on the other is confirmed by the analyses. These relationships are fully robust and the estimated magnitudes are similar across models. The only qualification is that alternative measures of the urban-rural imbalance (which are deemed inferior measures) do not fully substantiate the hypothesis.

A positive relationship between a terms of trade shock and per capita infrastructure expenditures was hypothesized. The estimated relationship is an inverted U, peaking when the terms of trade deteriorate by approximately nine percent, so that the hypothesized positive relationship only holds when there is a very serious deterioration in the terms of trade. It fails to hold when the terms of trade improve. Further, the significance of the coefficients is low. It was hypothesized that when direct foreign investment was an important source of foreign funding, central budget infrastructure expenditures would be larger. The hypothesized positive relationship between direct foreign investment and infrastructure expenditures only holds when direct foreign investment is a very large percentage of GDP (nearly a full standard deviation above the sample mean value). The estimated U shaped relationship found indicates that for most countries, increased direct foreign investment actually induces lower central budget expenditures on infrastructure. It may be that, in the general case, foreign investors directly provide infrastructure which governments otherwise would have provided; only when direct foreign investment is seen as a key element in the development strategy and a serious effort is made to attract foreign investment via the establishment of export platforms does direct foreign investment increase government infrastructure expenditures.

Contrary to what was hypothesized, countries with large debt obligations spend more on infrastructure. The negative relationship hypothesized was premised on the assumption that debt servicing receives priority over other expenditure categories. While it is unlikely that "discretionary" expenditures dominate debt servicing in the allocation of funds, the findings indicate that infrastructure expenditures are protected even in the face of large debt service obligations. It may be that governments choose to protect infrastructure investments, and scale back other discretionary expenditures, given the link between infrastructure development and export capacity; exports are necessary to earn the foreign exchange required to service the debt. The finding is not fully robust. When debt obligations are measured relative to exports (TDS) as opposed to GDP (DSGDP), significance levels fall and the estimated coefficient is insignificant in some models. When the total debt as a proportion of GDP is used (DODGDP), the estimated coefficient is never significant and, in fact, carries the hypothesized sign.

For nine of the variables hypothesized to influence per capita infrastructure expenditures (stock of infrastructure, population density, labor force participation rate, internal balance, external balance, institutional development, official flows, commercial bank flows and poverty commitment), no *a priori* hypothesis could be made concerning the nature of the relationship given the opposing forces at work. As noted above, no significant relationship is found between either the internal balance or official foreign funding flows on the one hand and infrastructure expenditures on the other. The findings indicate that greater per capita central budget infrastructure expenditures result when the stock of infrastructure is larger, the external balance improves, institutional development is better or commercial bank flows are a larger component of foreign funding flows. While the findings for institutional development and commercial bank flows are fully robust, those for the stock of infrastructure and the external balance are not. For the stock of infrastructure, the hypothesis holds when a narrow definition of infrastructure is adopted (roads plus rail kilometers); no significant relationship is found when the stock of infrastructure is measured broadly as the total capital stock. Concerning the external balance, the magnitude of the estimate is sensitive to the model used and how the level of development and infrastructure stock are measured. Further, when DOLLAR4 replaces TBWTGDPL, no significant relationship is found.

The findings robustly indicate expenditures decrease with higher labor force participation rates. Finally, the findings indicate that as the population density and degree of poverty commitment increase, central budget per capita infrastructure expenditures initially increase, but subsequently decrease. For population density, the peak of the inverted U occurs at density levels considerably greater than the sample mean population density; for poverty commitment, the peak occurs when poverty commitment levels are near the sample mean. Both of these findings are robust. It should be noted, again, that the level of poverty is an inappropriate proxy for the degree of poverty commitment.

The elasticity estimates presented in Table 8 provide considerable guidance concerning which factors have the greatest influence on per capita central government infrastructure expenditures. The urbanization rate, labor force participation rate and level of development are the most important determinants of infrastructure expenditures and all have elasticities greater than 1 in absolute value at the sample mean. The urban-rural balance, size of the foreign sector and institutional development have a substantial impact on per capita central government infrastructure expenditures with elasticity estimates between 0.4 and 1.0 in absolute value at the sample mean. The stock of infrastructure, population density and debt obligations only exert a small influence on central government infrastructure expenditures; elasticity estimates for these variables are between 0.3 and 0.1 in absolute value at the sample mean. Finally, the external balance, terms of trade shocks, poverty commitment, level of foreign funding, commercial bank flows and direct foreign investment only have a tiny impact on central government infrastructure expenditures, with elasticity estimates below 0.1 at the sample mean.

C. Determinants of Per Capita Consolidated Budget Expenditures on Infrastructure

Appendix C presents the signs and significance levels of variables for all sensitivity analyses undertaken to isolate the determinants of per capita consolidated budget expenditures on infrastructure without any correction for autocorrelation.[13] All regressions are highly significant with adjusted R^2s ranging from .66 to .82, but typically in the .69 to .74 range. Five of the variables thought to influence per capita infrastructure expenditures are generally insignificant. Terms of trade shocks appear to have no influence on consolidated budget per capita infrastructure expenditures, nor do debt obligations, or the degree of poverty commitment. After controlling for the total level of foreign funding flows, official flows, whether defined to include IMF credits or not, have no impact on consolidated budget infrastructure expenditures. The trade balance, *per se*, has no influence on consolidated budget expenditures, although other indicators suggest the external balance may be of some consequence. The sensitivity of consolidated budgetary outlays on infrastructure to the existing stock of infrastructure depends upon how the stock is measured, while the other eleven variables are robustly significant across all base runs, although there are some minor variations across runs in the magnitude of their impact. Except for sensitivity analyses exploring the role of the external balance, all sensitivity analyses confirm the basic relationships found in the base runs.

1. Stock of Infrastructure

Table C1 in Appendix C presents the signs and significance levels of variables for the alternative OLS base regressions. As for the central budget estimates, four different bases are considered, differing by how the stock of infrastructure is measured. For each alternative base, five regressions are included: M1 excludes the influence of foreign savings, M2 includes the level of foreign savings, but ignores the mix, M3, M4 and M5 explore how the mix of foreign savings flows (official, commercial bank, and direct foreign investment, respectively), influence per capita consolidated infrastructure expenditures.

The effect of the stock of infrastructure on per capita consolidated budget infrastructure expenditures is sensitive to how the stock of infrastructure is measured. As for central budget expenditures, when the infrastructure stock is measured broadly as KO2, no significant relationship is found. However, when the infrastructure stock is measured narrowly as the kilometers of roads and rail, the coefficient is always positive, although not significantly so when the stock of roads and railways is measured relative to GDP per capita. The estimated coefficients are larger than found for central government expenditures when the stock is measured relative to land area and GDP per capita, but slightly smaller, when measured relative to the population. As in the central budget estimates, the effect is nonlinear when measured relative to the population.

A one kilometer increase in the stock of roads and rail per thousand square kilometers land area increases infrastructure expenditures by about US 1980 $0.02 per capita (as opposed to 0.01). A one kilometer increase in the stock per US 1980 $ GDP increases per capita infrastructure expenditures by about four tenths of a cent. At the sample mean, the estimated elasticities are 0.25, 0.04 and 0.21 when the stock of roads and railways are measured relative to the land area, GDP and the population, respectively. These magnitudes are similar to those found for central government expenditures.

Overall, a conclusion that the stock of infrastructure increases per capita consolidated infrastructure expenditures by a less than proportionate amount is warranted. The impact of expenditures needed to offset depreciation of the existing infrastructure stock and/or complementarity between infrastructure and the structure of the economy, more than fully offsets the effect of diminishing returns to infrastructure expenditures.

As was found for central government expenditures, the significance of other variables as determinants of per capita infrastructure expenditure is quite robust across the alternative bases. Because the regressions defining the stock of infrastructure as the total kilometers of road and rail per 1000 square kilometers land area, FCINFPA, perform marginally better overall, this definition also will be used as the base for the sensitivity analyses exploring the determinants of consolidated budget per capita infrastructure expenditures. The full results of the five regressions (M1 through M5) using FCINFPA to define the stock of infrastructure are shown in Table 9.

The results shown in Table 9 do not include any correction for possible autocorrelation. Table 10 provides the basis for our test for autocorrelation. Table 10 shows the results of the same regression set, but includes dummy variables for year. As before, Y81 is set equal to 1 if the observation is from 1981, but zero otherwise, and so on; the omitted year is 1980. There is no evidence of autocorrelation. The F values for the joint significance tests of the dummy variables for year are 0.51, 0.42, 0.47, 0.35, and 0.62, for models M1, M2, M3, M4, and M5, respectively. The critical $F_{Q-K,n-Q}$ value at the 20 percent significance level is greater than 1.40 in all cases. Further, the coefficient magnitudes are quite comparable between estimates, as are significance levels for the independent variables. As before, in the absence of any evidence of autocorrelation, the sensitivity analyses are undertaken excluding any control for the year of observation.

2. *Population Density*

As can be seen from Tables 9 and 10 and Appendix C, population density is significant at the .01 level or better in all base runs and all sensitivity analyses with the exception of those including poverty level as opposed to poverty commitment. The relationship is strictly negative (whereas an inverted U relationship was found in the central budget case); higher population densities are associated with lower per capita consolidated budget infrastructure expenditures. The estimated sign reflects the fact that high population densities necessitate lower expenditure for a given level of infrastructure service. In the consolidated budget case, this factor offsets any tendency for economies of scale to dictate a high optimal level of provision in more densely populated countries.

At the sample mean the estimated elasticity calculated from Table 9 is -.33, opposite in sign and somewhat larger in magnitude than that found for central budget expenditures. At the sample mean, population density decreases infrastructure expenditures by about (1980) US $ 6.43. The size of the estimated impact is somewhat smaller (in absolute value) in the case of the alternative bases and the sensitivity analyses utilizing alternative indicators of the sectoral imbalance, but somewhat larger in the sensitivity analyses measuring development level in purchasing power parity dollars, measuring debt obligations as DODGDP1, and measuring the external balance as DOLLAR4, as well as in the runs using HDRPOOR and WBPOOR. Overall, the differences in the size of the estimated coefficients found are not large.

Table 9. Consolidated Budget Base Infrastructure Regressions

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
INTERCEPT	52.06*** (3.99)	48.81*** (3.91)	48.21*** (3.83)	56.57*** (4.54)	56.22*** (4.64)
FCINFPA	1.91E-2*** (3.24)	1.97E-2*** (3.49)	1.95E-2*** (3.43)	2.15E-2*** (3.89)	2.08E-2*** (3.82)
GDPCAPK	2.80E-2*** (4.40)	3.13E-2*** (5.10)	3.18E-2*** (5.07)	2.94E-2*** (4.89)	2.89E-2*** (4.87)
GDPCPKSQ	-1.76E-6 (-0.92)	-3.05E-6 (-1.65)	-3.01E-6 (-1.62)	-2.89E-6 (-1.60)	-2.48E-6 (-1.39)
DENS	-6.40E-2*** (-5.94)	-5.92E-2*** (-5.72)	-5.84E-2*** (-5.50)	-5.89E-2*** (-5.84)	-5.48E-2*** (-5.36)
URBAN4	-5.33E-1*** (-4.52)	-5.47E-1*** (-4.86)	-5.62E-1*** (-4.73)	-5.37E-1*** (-4.90)	-5.77E-1*** (-5.33)
MIGZ	6.64*** (3.52)	6.35*** (3.53)	6.38*** (3.53)	6.98*** (3.96)	6.64*** (3.85)
MIGZSQ	-5.90E-1*** (-2.93)	-5.76E-1*** (-2.99)	-5.82E-1** (-3.01)	-6.30E-1*** (-3.35)	-6.14E-1*** (-3.33)
LFPER	-8.07E-1*** (-3.29)	-7.89E-1*** (-3.37)	-7.83E-1*** (-3.33)	-8.85E-1*** (-3.74)	-7.61E-1*** (-3.40)
BBGDPL	-4.27E-1** (-1.98)	-5.14E-1** (-2.48)	-5.10E-1** (-2.45)	-4.57E-1** (-2.26)	-3.47E-1* (-1.70)
TVALX2	28.64*** (3.02)	21.68** (2.34)	19.38* (1.78)	17.45* (1.91)	9.09 (0.91)
TBWTGDPL	-8.58E-2 (-0.58)	-4.30E-2 (-0.31)	-3.35E-2 (-0.23)	-2.91E-2 (-0.21)	-1.14E-1 (-0.82)
TOTS	6.65E-2 (0.78)	8.15E-2 (1.00)	8.19E-2 (1.00)	8.04E-2 (1.02)	6.60E-2 (0.71)
DSGDP	-9.20E-3 (-0.03)	-3.69E-1 (-1.11)	-3.60E-1 (-1.08)	-4.18E-1 (-1.29)	1.29E-1 (0.37)

Table 9 (Con't). Consolidated Budget Base Infrastructure Regressions

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
GASTIL	-12.42***	-11.49***	-11.35***	-12.94***	-12.83***
	(-3.56)	(-3.44)	(-3.36)	(-3.92)	(-3.98)
GASTILSQ	1.40***	1.35***	1.33***	1.50***	1.47***
	(3.22)	(3.25)	(3.19)	(3.68)	(3.70)
PCOM	7.87E-2	1.52E-1	1.92E-1	-1.78E-1	-5.11E-1
	(0.08)	(0.16)	(0.20)	(-0.19)	(-0.55)
NFFCAP1K	-	3.17E-2***	3.04E-2***	2.99E-2***	3.05E-2***
		(3.51)	(3.14)	(3.39)	(3.36)
NOFGDP1	-	-	1.85E-1	-	-
			(0.41)		
NCBGDPSQ	-	-	-	3.00E-1***	-
				(2.75)	
DFIGDP	-	-	-	-	-4.48**
					(-2.55)
DFIGDPSQ	-	-	-	-	1.52***
					(3.43)
R^2	0.7308	0.7571	0.7574	0.7723	0.7815
Adjusted R^2	0.6934	0.7208	0.7188	0.7360	0.7444
F-Value	19.515	20.897	19.601	21.287	21.083
N	132	132	132	132	132

*** Significant at the .01 level
** Significant at the .05 level
* Significant at the .10 level

3. *Urbanization*

Urbanization reduces per capita consolidated budget infrastructure expenditures, *ceteris paribus*, as hypothesized and was found for central budget expenditures. As can be seen from Tables 9 and 10 and from Appendix C, the estimated coefficient for URBAN4 is significantly negative at the 1 percent level in all base runs and sensitivity analyses except the estimates replacing PCOM with HDRPOOR and WBPOOR where the significance levels are somewhat lower. The estimated elasticity at the sample mean is -1.15, marginally greater than was found for central budget infrastructure expenditures. A one percentage point increase in the urbanization rate reduces per capita consolidated budget expenditures on infrastructure by approximately (1980) US $ 0.55, also marginally more than was found for central budget expenditures. Although there is virtually no variation in the size of the estimated coefficient across base runs, there is minor variation in the estimated size of the coefficient in the sensitivity analyses.

4. Sectoral Balance

Consolidated budget infrastructure expenditures increase with the extent of the imbalance between rural and urban sectors, as was hypothesized. While a strictly linear and positive relationship was found for the central budget, here the effect is nonlinear. However, the peak of the inverted-U occurs when MIGZ is 5.52 (as calculated from Table 9, M2), more than two standard deviations above its mean value, so that except when the imbalance is exceptionally pronounced, the positive relationship holds. The coefficient for the rural-urban migration rate, MIGZ, is significant at the 1 percent level in most regressions and that for its square at the 5 percent level or better as can be seen from Tables 9 and 10 and Appendix C. There are a few cases when these variables are not highly significant; when DOLLAR4 is used to measure the external balance, the quadratic term is not significant, and when WBPOOR is substituted for PCOM, nether term is significant.

The magnitude of the estimated coefficients across sensitivity analyses is generally between 6.0 and 7.5 for the linear term and .45 to .65 for the quadratic term. The magnitude of the estimated coefficients is somewhat smaller in the alternative bases, and when PCOM is omitted from the regression or several of the poverty measures are substituted for PCOM. It is somewhat greater when GDPCAP2 replaces GDPCAPK in the regressions and when DOLLAR4 is used to measure the external balance, and it is considerably greater when HDRPOOR replaces PCOM. Focusing on the FCINFPA base regression in Table 9 including foreign flows, but not the mix of foreign funding, one finds that when the migration rate increases by one percentage point from the mean, per capita consolidated budget expenditures on infrastructure increase by about (1980) US $ 4.50. This is the same rate of increase found for central budget infrastructure expenditures. The estimated elasticity at the mean is 0.37; the comparable figure for central budget infrastructure expenditures was 0.41.

Table 10. Consolidated Buget Base Infrastructure Regressions with Time Dummies

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
INTERCEPT	53.12*** (4.00)	49.12*** (3.85)	48.01*** (3.72)	56.69*** (4.43)	58.00*** (4.68)
FCINFPA	2.06E-2*** (3.37)	1.95E-2*** (3.33)	1.90E-2*** (3.20)	2.10E-2*** (3.65)	2.16-2*** (3.84)
GDPCAPK	2.85E-2*** (4.40)	3.16E-2*** (5.05)	3.24E-2*** (5.07)	2.97E-2*** (4.83)	2.90E-2*** (4.82)
GDPCPKSQ	-1.89E-6 (-0.98)	-3.09E-6 (-1.64)	-3 .03E-6 (-1.60)	-2.93E-6 (-1.59)	-2.49E-6 (-1.37)
DENS	-6.47E-2*** (-5.91)	-5.90E-2*** (-5.57)	-5.74E-2*** (-5.25)	-5.82E-2*** (-5.64)	-5.37E-2*** (-5.12)
URBAN4	-5.50E-1*** (-4.56)	-5.46E-1*** (-4.73)	-5.69E-1*** (-4.70)	-5.34E-1*** (-4.74)	-5.92E-1*** (-5.35)
MIGZ	6.75*** (3.52)	6.42*** (3.50)	6.46*** (3.51)	6.99*** (3.88)	6.80*** (3.88)
MIGZSQ	-5.98E-1*** (-2.92)	-5.83E-1*** (-2.97)	-5.92E-1*** (-3.00)	-6.32E-1*** (-3.29)	-6.33E-1*** (-3.38)
LFPER	-8.44E-1*** (-3.37)	-7.85E-1*** (-3.27)	-7.70E-1*** (-3.18)	-8.40E-1*** (-3.57)	-7.58E-1*** (-3.31)
BBGDPL	-4.02E-1* (-1.78)	-5.16E-1** (-2.36)	-5.12E-1** (-2.33)	-4.65E-1** (-2.17)	-3.52E-1 (-1.65)
TVALX2	26.27** (2.53)	22.24** (2.22)	18.78 (1.65)	18.25* (1.85)	4.80 (0.43)
TBWTGDPL	-4.31E-2 (-0.26)	-7.82E-2 (-0.50)	-7.36E-2 (-0.47)	-7.50E-2 (-0.49)	-1.10E-1 (-0.72)
TOTS	6.86E-2 (0.77)	9.89E-2 (1.16)	1.00E-1 (1.18)	9.59E-2 (1.15)	6.45E-2 (0.79)
DSGDP	6.07E-2 (0.16)	-4.71E-1 (-1.20)	-4.90E-1 (-1.25)	-5.34E-1 (-1.40)	2.56E-1 (0.61)
GASTIL	-11.74*** (-3.24)	-11.83*** (-3.42)	-11.70*** (-3.37)	-13.33*** (-3.90)	-12.75*** (-3.86)

Table 10 (Con't). Consolidated Buget Base Infrastructure Regressions with Time Dummies

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
GASTILSQ	1.32***	1.40***	1.38***	1.55***	1.48***
	(2.95)	(3.25)	(3.21)	(3.67)	(3.61)
PCOM	1.12E-1	1.66E-1	2.31E-1	-1.66E-1	-5.61E-1
	(0.11)	(0.17)	(0.24)	(-0.18)	(-0.59)
NFFCAP1K	-	3.43E-2***	3.30E-2***	3.35E-2***	3.03E-2***
		(3.34)	(3.14)	(3.35)	(2.98)
NOFGDP1	-	-	3.10E-1	-	-
			(0.64)		
NCBGDPSQ	-	-	-	2.94E-1**	-
				(2.59)	
DFIGDP	-	-	-	-	-4.62**
					(-2.56)
DFIGDPSQ	-	-	-	-	1.64***
					(3.50)
Y81	-5.86E-1	-1.22	-1.43	-1.65	-2.75
	(-0.19)	(-0.41)	(-0.48)	(-0.57)	(-0.96)
Y82	3.00E-2	-2.27E-1	-3.02E-1	-1.01	-2.54
	(0.01)	(-0.08)	(-0.10)	(-0.34)	(-0.85)
Y83	-1.06E-1	-6.86E-1	-6.81E-1	-9.42E-1	-3.51
	(-0.03)	(-0.21)	(0.21)	(-0.30)	(-1.10)
Y84	-1.71	-1.04	-9.06E-1	-9.68E-1	-2.45
	(-0.54)	(-0.34)	(-0.30)	(-0.33)	(-0.83)
Y85	2.32E-1	2.80	3.17	2.32	-1.00E-1
	(0.07)	(0.84)	(0.93)	(0.71)	(-0.03)
Y86	-4.21	-8.84E-1	-4.50E-1	-3.29E-1	-4.10
	(-1.24)	(-0.26)	(-0.13)	(-0.10)	(-1.22)
R^2	0.7381	0.7627	0.7636	0.7767	0.7889
Adjusted R^2	0.6853	0.7122	0.7186	0.7267	0.7391
F-Value	13.965	15.091	14.401	15.511	15.841
N	132	132	132	132	132

*** Significant at the .01 level
** Significant at the .05 level
* Significant at the .10 level

The findings are sensitive to how the sectoral balance is measured, as can be seen from Table C2 in Appendix C. The share of GDP in the agricultural sector, SAGR4 positively influences consolidated budget per capita infrastructure expenditures, implying as the sectoral balance improves, infrastructure expenditures increase rather than decrease. As the level of agricultural income increases, consolidated infrastructure expenditures initially increase, but subsequently decrease. The peak of the inverted U relationship occurs when AGCAPK equals US (1980) $ 1238, over three standard deviations above the sample mean value, implying that over the sample range this relationship is positive as well, contrary to expectations. The same anomaly was found for central government infrastructure expenditures. As was noted then, these proxies for rural welfare measure differences between rural and urban welfare levels less effectively than migration rates, since as the level of development increases, the share of income earned in rural areas from agricultural activities tends to decrease. Neither SAGR4 nor AGCAPK accounts for this fact or for differences in social service provision between sectors.

5. Labor Force Participation Rate

The sign of the coefficient on the labor force participation rate, LFPER, is robustly negative, and with few exceptions significant at the 1 percent level. As was the case for central budget infrastructure expenditures, consolidated budget infrastructure expenditures decrease as the labor force participation rate increases. As before, the findings imply that labor and public infrastructure are net substitutes in production and/or that, *ceteris paribus*, higher population growth rates induce higher per capita expenditures on infrastructure.

The magnitude of the impact of the labor force participation rate is substantial. When the labor force participation rate increases by one percentage point, consolidated budget per capita infrastructure expenditures typically decrease by about (1980) US $ 0.80 as can be seen from Tables 9 and 10. At the sample mean this implies an elasticity of -1.48. These values are somewhat lower (in absolute value) than those found for central budget expenditures, but remain substantial.

6. Level of Development

The level of GDP per capita positively influences per capita consolidated budget infrastructure expenditures, as hypothesized. Unlike central budget expenditures, evidence of any dampening is weak at best, as can be seen from Tables 9 and 10 and Appendix C. The linear term is significant at the one percent level in all regressions except some of those where PCOM is replaced with a poverty incidence estimate. It is likely that multicollinearity reduces significance levels in these cases. The quadratic term is seldom significant even at the 10 percent level; notable exceptions include the runs measuring the stock of infrastructure as kilometers of roads and rail relative to GDP per capita, and runs exploring the alternative sectoral balance indicators. The sign of the quadratic term is, however, consistently negative.

The variation in the size of the estimated coefficients is small; a one $ increase in GDP per capita increases consolidated infrastructure expenditures by approximately (1980) US $ 0.03. Given the limited evidence of any nonlinear effect, it makes sense to compute the elasticity from the linear term alone. If one does so, the estimated elasticity is 1.83, higher than that found in the case of central budget expenditures. However, if one considers that multicollinearity may have reduced the estimated significance of the quadratic term, then the estimated elasticity is 1.42, just under that found for central budget expenditures.

The findings are quite comparable when one measures level of development on the basis of purchasing power parity dollars, as can be seen from Table C3 in Appendix C. The relationship between GDPCAP2 and consolidated budget per capita infrastructure expenditures is robustly positive and is consistently significant at the 1 percent level. The quadratic term is generally, but not always, negative but never significant even at the 15 percent level. The coefficient magnitudes imply an elasticity at the sample mean of about 1.30, whether or not the elasticity calculation takes account of the quadratic term. This again is somewhat lower than that found for central budget infrastructure expenditures.

7. *Internal Balance*

The results of the consolidated budget per capita infrastructure expenditure regressions provide mixed results concerning how governments adjust infrastructure expenditures in response to fiscal crises. The estimated coefficient for BBGDPL is always negative and is generally significant at the 5 percent level or better, implying that as the budget balance deteriorates, consolidated budget per capita expenditures on infrastructure increase. Across sensitivity analyses, the estimated coefficients range within fairly narrow bounds, generally between -0.26 and -0.58. This implies that when there is a budget deficit (BBGDPL$<$0), a further deterioration [improvement] in the budget balance leads to an increase [decrease] in consolidated budget per capita infrastructure expenditures. The estimated elasticity at the sample mean is 0.17 (calculated from Table 9, M2), given the sample mean value for BBGDPL of -6.6.

Table C4 in Appendix C shows the results of the sensitivity analysis comparing results for INFL4 with those for BBGDPL. The signs are inconsistent with the results for BBGDPL; INFL4 is negatively (but nonlinearly) related to consolidated budget infrastructure expenditures. This implies that as the budget balance deteriorates, inducing inflation, governments respond by scaling back infrastructure expenditures in apparent contradiction to the findings for BBGDPL. However, significance levels are low. The coefficients are only significant at the 10 or 15 percent level. The magnitude of the estimated coefficients indicate that consolidated budget expenditures on infrastructure decrease as the inflation rate increases until the inflation level reaches 241 percent, more than three standard deviations above the sample mean inflation value. At the sample mean, the estimated elasticity is -0.12, the same estimated elasticity value found for central budget expenditures.

The resolution of the apparently contradictory findings may lie in the question of whether or not a given budget deficit is sustainable. Deficit spending to finance productive infrastructure expenditures may be part of a strategy to speed up the rate of GDP growth. Governments may utilize this strategy so long as inflation remains in check. However, once prudent financing strategies are exhausted and inflation begins to rise, deficit increasing infrastructure expenditures may be scaled back in an effort to stabilize the economy.

8. *External Balance*

The regression runs using the trade balance relative to GDP lagged one year (TBWTGDPL) provide no evidence that the external balance influences consolidated budget infrastructure expenditures. While the estimated sign of the coefficient is generally negative, it is never significant even at the 15 percent level, as can be seen from Tables 9 and 10 and Appendix C.

One's conclusion concerning the importance of the external balance for consolidated infrastructure expenditures is sensitive to how the external balance is measured, as can be seen from Table C5 in Appendix C. When the external balance is assessed on the basis of the black market foreign exchange premium, BLACK, a robust negative and highly significant relationship is found; The greater is the black market foreign exchange premium, the lower are consolidated budget per capita infrastructure expenditures. The value of the coefficient is about -.04, implying an elasticity of -0.07, so the impact is not very pronounced. This conclusion is further substantiated by the results of the regressions using DOLLAR4 as an index of external balance. Recall, that DOLLAR4 is actually an index of trade orientation, with low values (below 100) corresponding with inward orientation and high values (above 100) corresponding with outward orientation. One expects the external balance will be worse the lower is the value of DOLLAR4. If a poor external balance reduces infrastructure expenditures, then the estimated coefficient for DOLLAR4 should be positive. This is exactly what is found. The estimated coefficient for DOLLAR4 is positive and significant at the .05 level or better in all regressions. When DOLLAR4 increases by 1 unit (implying a very substantial movement towards outward orientation since this variable only ranges between 98 and 102), per capita consolidated budget infrastructure expenditures increase by between (1980) US $3.00 and $3.50. The corresponding elasticity estimate at the sample mean is 16.81.

An overall conclusion that the external balance does influence consolidated infrastructure expenditures appears warranted. Substantial infrastructure expenditures appear to be required to remain competitive internationally.

9. *Size of the Foreign Sector*

There is considerable evidence that as the size of the foreign sector increases, per capita consolidated infrastructure expenditures increase, as hypothesized. The finding is not as robust, nor is the estimated impact as great, as it was for central government infrastructure expenditures, perhaps because revenues from import and export earnings accrue primarily to the central government. In the consolidated budget case, the estimated coefficients are generally positive, but significance levels vary, typically 5 percent level or better in models M1 and M2, the 10 percent level in models M3 and M4, and worse than the 15 percent level in model M5. There is also variation in the estimated impact and significance levels across sensitivity analyses as can be seen from Tables 9 and 10 and Appendix C. The estimated coefficient is highly significant in the runs measuring level of development in purchasing power parity dollars; the coefficients are insignificant in the runs exploring alternative indicators of sectoral balance and some of the poverty indices. The estimated coefficient tends to fall between 5 and 29, with the higher value obtained for M1 and the lower value obtained for M5. However, the range estimate is higher in the runs with INFL4, GDPCP2, DOLLAR4, the alternative debt indicators and the alternative stock of infrastructure indicators. Negative estimated coefficient values obtain for some of the runs exploring alternative indicators of sectoral balance and replacing PCOM with alternative measures of the incidence of poverty.

In the base runs (Tables 9 and 10) measuring capital stocks as road and rail kilometers relative to land area, and including the level (but not mix) of foreign savings flows, the estimated coefficient is approximately 22, implying an elasticity of 0.25. This is less than half the comparable elasticity estimate for central budget infrastructure expenditures.

10. Terms of Trade Shocks

Evidence that terms of trade shocks influence consolidated budget per capita infrastructure expenditures is weak at best. While the estimated coefficient is generally negative, it is never significant even at the 15 percent level. Whereas some sensitivity of central budgetary expenditures to terms of trade shocks was found, consolidated budgetary infrastructure expenditures show no sensitivity. As in the case of TVALX2, this may simply be a reflection of the fact that it is the central government, as opposed to other levels of government, that receive taxes on export earnings.

11. Debt Obligations

As was found in the case of central government infrastructure expenditures, the evidence that consolidated budget per capita infrastructure expenditures are influenced by debt obligations is weak at best. The sign of the estimated coefficient is generally negative (whereas it was positive, but insignificant in the central budget case), but significantly so only when HDRPOOR replaces PCOM. In all the base runs (Tables 9 and 10) and in all the other sensitivity analyses, the significance level never reaches the 15 percent level. This finding is not sensitive to how debt service obligations are measured, as Table C6 Appendix C shows.

12. Institutional Development

As was the case for central government infrastructure expenditures, consolidated budget per capita infrastructure expenditures are influenced by the level of institutional development, as can be seen from Tables 9 and 10. However, whereas GASTIL was strictly negatively related to central government infrastructure expenditures (implying infrastructure expenditures increased as the level of institutional development increased), the relationship is U shaped for consolidated budget infrastructure expenditures. This implies that as the level of institutional development improves, consolidated budget per capita infrastructure expenditures initially increase, but eventually decrease.

The estimated coefficients for both the linear and quadratic term are significant at the 1 percent level in all base runs and virtually all sensitivity analyses. There is some variation in the range of the estimated coefficients. Generally, the estimated coefficient for the linear term is between -15 and -11, while that for the quadratic term is between 1.1 and 1.7. This implies that the trough of the U occurs at a value just above or below the sample mean value for GASTIL. In Table 9's base regression measuring the stock of infrastructure as FCINFPA, and including the level but not mix of foreign funding, the trough of the U occurs when the value of GASTIL is 4.26. The sample mean value for GASTIL is 4.34, so that for this regression, at the sample mean, improvements in institutional development tend to reduce consolidated budget outlays on infrastructure. The corresponding elasticity estimate is, not surprisingly, small, 0.05, since the trough is near the sample mean value for GASTIL. Consolidated budget infrastructure expenditures would respond positively and more strongly to improvements in the level of institutional development in countries where the level of institutional development is lower.

13. Level and Mix of External Funding

Foreign savings flows positively influence consolidated budget per capita infrastructure expenditures as they did central government expenditures. External funding remains a significantly positive determinant of consolidated budget per capita infrastructure expenditures regardless of whether or not IMF credit is included in the tally of foreign savings flows, as can be seen from Table C7 in Appendix C. The estimated coefficient of NFFCAP1K/NFFCAP2K is always positive, and is generally significant at the 1 percent level as can be seen from Tables 9 and 10 and Appendix C. There are only a few exceptions. The significance level is lower when DOLLAR4 is used to assess the external balance and when HDRPOOR replaces PCOM. The estimated coefficient is not significant when the level of development is assessed on the basis of purchasing power parity dollars (GDPCAP2).

The estimated coefficients indicate that a (1980) US $ 1.00 increase in per capita foreign flows increase consolidated budget per capita infrastructure expenditures by about (1980) US $ 0.03. The implied elasticity at the sample mean is 0.09, somewhat larger than was found for central budget expenditures. The estimated magnitude of the impact is surprisingly stable across all sensitivity analyses.

The mix of foreign funding influences consolidated budget infrastructure expenditures. The nature of the influence is similar, but not identical to that found in the case of central budget infrastructure expenditures. Holding the level of funding constant, countries with a high proportion of official flows spend neither more nor less than those with a low proportion of official flows. This finding holds regardless of whether IMF flows are included or excluded from the official flow tally, as can be seen from Table C7. However, as the proportion of commercial bank flows increases, per capita consolidated budget infrastructure expenditures increase at an increasing rate. At sample means, the estimated elasticity is 0.48, much greater than was found for central budget infrastructure expenditures. As was found for central budget infrastructure expenditures, as the share of direct foreign investment increases (holding the total level of foreign flows constant), consolidated budget infrastructure expenditures initially fall, but subsequently rise. The estimated elasticity at the sample mean is -0.08. The trough of the relationship occurs when the level of direct foreign investment reaches about 1.5 percent of GDP, somewhat less than one standard deviation above the sample mean. Direct foreign investment only induces increased consolidated per capita infrastructure expenditures in countries where the level of foreign investment is exceptionally high. These findings are robust across base runs and sensitivity analyses.

14. Government Objectives -- Poverty Commitment

Consolidated per capita infrastructure expenditures do not respond to the level of poverty alleviation commitment as assessed by PCOM. This finding is robust across all base runs and sensitivity analyses. The estimated sign of PCOM is inconsistent across runs, and the coefficient is never significant even at the 15 percent level, as can be seen from Appendix C. Indicators of poverty levels, as opposed to our indicator of poverty commitment, do no better. The signs are inconsistent across runs and the coefficients are never significant as can be seen from Tables C8.

The findings of regressions including poverty incidence indicators, as opposed to our poverty commitment indicator, are consistent with those found for the central budget regressions. However, poverty alleviation commitment, PCOM, was found to significantly influence central government per capita infrastructure expenditures, while PCOM does not influence consolidated budget expenditures. It may be that at lower levels of government, investments in infrastructure are not viewed as an effective means to alleviate poverty. However, it may also be that there is a relationship, but because our review of documents only focused on the central government, the variable PCOM is a poor indicator of the extent of commitment to poverty alleviation at lower levels of government. This issue warrants further exploration.

15. Consolidated Budget Per Capita Infrastructure Expenditures: Summary and Conclusions

Table 11 summarizes the overall results of the analysis for consolidated per capita infrastructure expenditures. The table shows the hypothesized relationship between the different variables and per capita consolidated budget expenditures, and the direction of the estimated relationship. The instantaneous rate of change in infrastructure expenditures and the elasticity are shown as computed for the sample mean values of the independent variables. In the case of nonlinear relationships, the estimated peak or trough is indicated. The values without parentheses are those corresponding to Table 9's FCINFPA base regression including foreign funding, M2, and, except where relevant, excluding the mix of foreign funding. The values in parentheses are those corresponding to the comparable regression including the dummy variables for year (Table 10).

Among all the factors hypothesized to influence consolidated budget expenditures on infrastructure, four are found to have no impact. Two factors, terms of trade shocks and debt service obligations, were hypothesized to have a positive and negative influence, respectively, on consolidated budget infrastructure expenditures. No significant relationship is found for either of these variables. Part of the explanation may lie in the central government's claim on export tax revenues and responsibility for debt service payments. These factors are not likely to play as prominently in financing capabilities, obligations and, accordingly, decisions at lower levels of government. We would, however, have expected an influence through changes in central government transfers to lower levels and due to the fact that the central budget is one component of the consolidated budget.

No *a priori* hypothesis could be made concerning the impact of government objectives or official foreign savings on infrastructure expenditures. Government commitment to poverty alleviation, as assessed by PCOM, had no influence on consolidated infrastructure expenditures. This could reflect different and offsetting strategies for poverty alleviation between the central government and lower levels of government. It could also be that the extent of commitment to poverty alleviation differs by level of government, and that while PCOM reasonably reflects the central government's commitment, it only poorly reflects the overall commitment to poverty alleviation. Holding the level of foreign savings flows constant, infrastructure expenditures are not sensitive to whether a large or small share of foreign savings flows arise from official transfers. Holding the level of foreign savings flows constant, countries with a high level of official flows allocate about the same amount to infrastructure expenditures as those receiving a low level of official flows.

Five factors, the stock of infrastructure, the level of development, the size of the foreign sector, the level of foreign savings flows, and the share of commercial bank flows in total savings flows, are found to positively influence consolidated budget per capita infrastructure expenditures. For the first four factors, the impact is linear, while for commercial bank flows, the rate of impact increases.

For the stock of infrastructure, offsetting forces were hypothesized. The results from the consolidated budget expenditure regressions indicate that diminishing returns are offset by the expenditure required to offset depreciation of the existing stock of infrastructure or cross country differences in the degree of complementarity between infrastructure and the existing productive structure of the economy. The result is not, however, robust across all definitions of the stock of infrastructure. In particular, no significant relationship is found when the stock is measured as the road and rail kilometers relative to the GDP, or more broadly as the total capital stock (private plus public) of the country.

The level of development was hypothesized to positively, but possibly nonlinearly, influence the level of infrastructure expenditures, since government services and goods are expected to be normal goods, and structural changes accompanying development are expected to increase the return to infrastructure investments. The linear and positive relationship found for consolidated budget per capita infrastructure expenditures is robust and is not sensitive to how the level of development is measured.

The size of the foreign sector was also hypothesized to be positively related to the expenditures on infrastructure given the link between the size of the foreign sector and taxable capacity. Support for this hypothesis is robust. Similarly, the level of foreign savings flows was hypothesized to be positively related to government expenditures on infrastructure since these flows can either directly be used for infrastructure expenditures or reduce budgetary outlays for other items, freeing up funds for infrastructure investment. This hypothesis receives robust confirmation from the consolidated budget infrastructure expenditure regressions.

We speculated that, holding the total level of foreign savings flows constant, countries receiving a higher proportion of foreign funding in the form of commercial bank flows might allocate a different amount for infrastructure expenditures, although no *a prior* hypothesis was made concerning the direction of the impact. The results here robustly indicate that countries receiving a high proportion of foreign flows in the form of commercial bank loans spend more on infrastructure out of the consolidated budget. In fact, the estimated relationship indicates infrastructure expenditures increase at an increasing rate as the share of commercial bank loans in foreign savings flows increases.

In addition to the five factors mentioned above, there is qualified evidence that countries with a better external balance spend more out of the consolidated budget on infrastructure. While the trade balance relative to the GDP did not have a measurable impact on consolidated budget expenditures, the evidence indicates that countries with a lower black market exchange rate premium or that are more outward oriented do have higher consolidated budget per capita infrastructure expenditures. This finding implies that the focus of stabilization and structural adjustment programs on improving the external balance in and of itself tends to increase per capita consolidated infrastructure expenditures. However, to the extent that these programs succeed in improving the internal balance or inadvertently reduce GDP growth, this positive impact may be offset.

Four factors, population density, urbanization, the labor force participation rate and the internal balance are found to negatively influence consolidated budget infrastructure expenditures. Low population densities necessitate higher expenditures for a given level of infrastructure service and it is this force that drives the relationship. Countries with a higher proportion of the population in urban areas are found to have lower consolidated per capita infrastructure expenditures, also reflecting economies of scale. The negative relationship found between the labor force participation rate and consolidated budget infrastructure expenditures implies that labor and infrastructure are net substitutes in production. Given the likely correlation between labor force participation rates and the population growth rate, this relationship may also imply that, *ceteris paribus*, when population growth rates are higher, infrastructure expenditures increase.

The findings for the internal balance imply that when the budget balance deteriorates, per capita consolidated infrastructure expenditures increase. This may reflect a conscious policy to foster development by putting in place productive infrastructure to crowd in private investment. However, the results from the sensitivity analysis suggest this policy is only pursued so long as the deficit is sustainable and inflationary forces do not take hold.

Nonlinear effects on consolidated infrastructure expenditure are found for the rural-urban balance, institutional development and direct foreign investment. Holding the level of foreign savings flows constant, low levels of direct foreign investment tend to reduce consolidated budget outlays for infrastructure, while very high levels increase them. This is contrary to expectations; a strict positive relationship was hypothesized. As the sectoral balance deteriorates, consolidated infrastructure expenditures initially increase. Urban-rural migration places increasing pressure on governments to expand urban infrastructure; one means to stem migration is to increase infrastructure and service provision in the rural areas. Although the estimated relationship implies that infrastructure expenditures increase at a decreasing rate, the estimated peak expenditure level occurs at a very high level, implying the relationship is positive, as hypothesized, for most countries.

The relationship between GASTIL and consolidated budget infrastructure expenditures is U shaped, implying that as the level of institutional development improves, consolidated budget per capita infrastructure expenditures initially increase, but eventually decrease. The trough of the relationship occurs when GASTIL reaches a value just below the population mean value. Thus improvements in institutional development will increase consolidated budget per capita infrastructure expenditures in about half of the sample countries and decrease them in the other half. The nonlinear relationship found may reflect the juxtaposition of the two forces linking institutional development with infrastructure expenditures noted earlier on. When institutions begin to develop, and the market begins to flourish, private sector demand for productive public infrastructure may increase. However, once institutional development reaches a high enough level, the growing ability of the private sector to take over the supply of some forms of infrastructure provision may dominate.

Table 11. Consolidated Budget Infrastructure Expenditures: Summary of Results

Variable	Hypothesized Relationship	Estimated Relationship	Instantaneous Effect Effect 1 unit Increase	Peak or Trough	Elasticity at Mean
Stock of Infrastructure					
FCINFPA	?	>0	$0.02	–	0.25
			($ 0.02)		0.25)
Population Density					
DENS	?	<0	$-0.06	–	-0.34
			($-0.06)		(-0.33)
Urbanization					
URBAN4	<0	<0	$-0.55		-1.15
			($-0.55)		(-1.15)
Sectoral Imbalance					
MIGZ & MIGZSQ	>0	Inverted U	$4.45	5.52	0.37
			($4.50)	(5.51)	(0.38)
Labor Force Participation					
LFPER	?	<0	$-0.79	–	-1.48
			($-0.79)		(-1.47)
Level of Development					
GDPCAPK	>0 /Inverted U	>0	$0.03	–	1.83
			($0.03)		(1.85)
Internal Balance					
BBGDPL	?	<0	$-0.04	–	0.01
			($-0.08)		(0.01)
INFL4 & INFL4SQ	?	U Shaped	$-0.12	241	-0.12
External Balance					
TBWTGDPL	?	N.S.	–	–	–
BLACK	?	<0	$-0.04	–	-0.07
DOLLAR4	?	>0	$ 3.29	–	16.81
Size Foreign Sector					
TVALX2	>0	>0	$ 21.68	–	0.25
			($ 22.24)		(0.25)
Terms of Trade Shock					
TOTS	>0	N.S.	–	–	–
Debt Obligations					
DSGDP	<0	N.S.	–	–	–
Institutional Development					
GASTIL	?	U Shaped	$ 0.22	4.26	0.05
			($ 0.30)	(4.23)	(0.07)
Level Foreign Funding					
NFFCAP1K	>0	>0	$ 0.03	–	0.09
			($ 0.03)		(0.10)
Mix of Foreign Funding					
NOFGDP1	?	N.S.	–	–	–
NCBGDPSQ	?	U Shaped	$ 0.79	–	0.48
			($ 0.76)		(0.47)
DFIGDP & DFIGDPSQ	>0	U Shaped	$-2.25	$1.47	-0.08
			($-2.22)	($1.41)	(-0.08)
Poverty Commitment					
PCOM	?	N.S.	–	–	–

The elasticity estimates presented in Table 11 show how responsive consolidated budget per capita infrastructure expenditures are to each of the factors. The urbanization rate, labor force participation rate and level of development are the most important determinants of consolidated budget infrastructure expenditures. All have elasticities greater than 1 in absolute value at the sample mean. Population density, the sectoral balance, and commercial bank flows also have a substantial impact on consolidated budget per capita infrastructure expenditures with elasticities greater than 0.3, but less than 1.0 in absolute value, at the sample mean. The stock of infrastructure, the internal balance, and the size of the foreign sector only have a modest impact on consolidated budget infrastructures, with elasticities ranging between 0.1 and 0.3 in absolute value. Institutional development, the level of foreign savings flows, and the share of foreign investment in foreign savings flows only have a tiny impact on consolidated budget per capita infrastructure expenditures. The estimated elasticities are below 0.1 in absolute value at the sample mean. The relative importance of the different factors, especially those factors with nonlinear relationships, will differ for countries where the value of the factors concerned deviate substantially from the sample mean.

D. A Comparison of Analyses of Per Capita Infrastructure Expenditure Using Central Budget vs. Consolidated Budget Data

Most of findings regarding the determinants of public infrastructure expenditures are broadly consistent regardless of whether central budget or consolidated budget expenditures are the focus of concern. The most important determinants of infrastructure expenditures are the level of development, the urbanization rate and the labor force participation rate. The size of the foreign sector, sectoral balance, and the stock of infrastructure are also important determinants of per capita infrastructure expenditures. The level and mix of foreign funding play a lesser role, but influence central and consolidated budget per capita infrastructure expenditures in a similar fashion. There is only weak evidence that terms of trade shocks and debt service obligations significantly influence either central or consolidated budget expenditures, although the evidence is stronger for central government expenditures.

Despite these similarities, several factors appear to influence central and consolidated per capita infrastructure expenditures differently. Population density and institutional development, are important determinants of both central and consolidated budget expenditures, but the nature of the relationship differs. The internal balance and external balance appear to be more important determinants of consolidated than central government infrastructure expenditures. Finally, the central government's commitment to poverty alleviation influences central government expenditures on infrastructure, while it appears to have no influence on consolidated budget expenditures.

Infrastructure expenditures increase with the level of development. For central budget, but not consolidated budget expenditures, they are found to increase at a decreasing rate when the level of development is assessed on the basis of GDP per capita in constant

1980 US dollars. If the level of development is assessed on the basis of GDP per capita in 1985 purchasing power parity dollars, the effect is found to be strictly linear in both the central and consolidated budget case. The magnitude of the impact is substantial. Elasticity estimates at the sample mean are 1.69 and 1.83 for the central and consolidated budget estimates, respectively, when level of development is measured in constant dollars. When the level of development is measured on the basis of purchasing power parities, the respective elasticities are 1.57 and 1.30.

Higher urbanization and labor force participation rates are associated with lower per capita infrastructure expenditures. Of the two factors, the labor force participation rate has a stronger impact on infrastructure expenditures. For the labor force participation rate, the estimated elasticities at the sample mean are -2.73 and -1.48 for the central and consolidated budgets, respectively; the elasticity estimates for the urbanization rate are -1.10 and -1.15 for the central and consolidated budgets, respectively.

Per capita infrastructure expenditures are greater in countries with a large foreign sector. The size of the foreign sector is a more important determinant of central government expenditures than consolidated budget expenditures. This probably reflects the fact that export and import taxes tend to accrue to the central government. The estimated elasticities at the sample mean are 0.60 for central budget expenditures and 0.25 for consolidated budget expenditures.

A sectoral imbalance between rural and urban areas positively influences per capita infrastructure expenditures. The relationship is strictly linear in the case of central budget expenditures; consolidated budget expenditures on infrastructure increase at a decreasing rate as the imbalance grows. The magnitude of the estimated elasticities at the sample mean are comparable for both central and consolidated budget expenditures, 0.41 and 0.37, respectively.

As the stock of infrastructure increases, so do per capita infrastructure expenditures. The elasticity estimates are fully comparable between samples. For the central budget, the estimated elasticity at the sample mean is 0.23, while it is 0.25 for the consolidated budget.

The level of foreign savings flows is positively related to per capita infrastructure expenditures. Foreign savings flows in general are not particularly important determinants of per capita infrastructure expenditures. The elasticity estimates at the sample mean are only 0.06 and 0.09 for the central and consolidated budgets, respectively. There is an important qualification; the composition of foreign savings matters. When commercial bank flows are a high proportion of foreign savings, infrastructure expenditures are larger. Holding the level of foreign savings constant, the estimated elasticity with respect to commercial bank flows is 0.06 for the central budget and a much greater 0.47 for the consolidated budget. As the share of direct foreign investment in total foreign savings increases, infrastructure expenditures initially decrease, but eventually increase. The elasticity estimates at the sample mean (holding the level of foreign savings constant) are -0.06 and -0.08 for central and consolidated budget expenditures, respectively.

There is no evidence that terms of trade shocks significantly influence consolidated budget per capita infrastructure expenditures. The evidence of an impact on central budget expenditures is weak; the significance level of the estimated coefficients is generally between 10 and 15 percent. In any case, at the sample mean the impact is tiny; the elasticity estimate is only 0.01. Similarly the evidence that debt obligations influence central budget infrastructure expenditures is weak; there is no evidence that they influence consolidated budget infrastructure expenditures. In the central budget regressions, the estimated coefficient for the debt services obligation relative to GDP is positive, contrary to expectations, but the significance levels are low, generally in the 10 to 15 percent range. Significance levels do not even reach 15 percent when the alternative indicators of debt obligations are used.

While higher population densities are strictly negatively related to consolidated budget infrastructure expenditures, central government expenditures initially increase, but subsequently decrease as population densities rise. The peak of the relation occurs at about one and a half times the sample mean population density value, so that the estimated elasticity of central government infrastructure expenditures is positive, 0.24, at the sample mean. For consolidated budget expenditures, the comparable elasticity estimate is -0.33.

The opposite pattern is found for institutional development. For the central budget, as GASTIL rises (indicating a lower level of institutional development), per capita infrastructure expenditures decrease throughout. However, consolidated budget expenditures initially decrease as GASTIL rises, but begin increasing before GASTIL reaches the sample mean value. At the population mean, the elasticity estimate is accordingly negative and fairly large, -0.60, for central budget per capita infrastructure expenditures, but positive and quite modest, 0.05, for consolidated budget expenditures.

The budget deficit influences consolidated budget per capita infrastructure expenditures; as the budget deficit increases, per capita infrastructure expenditures increase. The elasticity estimate is 0.17 at the sample mean. However, the budget deficit *per se* has no significant impact on central government infrastructure expenditures. There is evidence that the sustainability of the deficit matters. As the rate of inflation increases, both central and consolidated budget infrastructure expenditures decrease, although at a decreasing rate. The elasticity estimates at the sample mean are both -0.12.

Evidence that the external balance influences per capita infrastructure expenditures is stronger for the consolidated than central government budget. Improvements in the trade balance are associated with greater central budget infrastructure expenditures, but significance levels are extremely low. There is no evidence that consolidated budget infrastructure expenditures move with the trade balance. However, outward orientation is strongly and positively associated with increased consolidated budget infrastructure expenditures. The elasticity estimate at the mean is 16.81. No significant relationship is found between trade orientation and central government infrastructure expenditures. As the black market foreign exchange premium increases, both central and consolidated budget infrastructure expenditures decrease. The significance levels of the estimated coefficients are, however, much greater in the consolidated budget case.

The central government's commitment to poverty influences central government expenditures on infrastructure. The relationship has an inverted U shape, so that near the sample mean value for PCOM, expenditures are highest. Governments that are not committed to poverty alleviation or have an extremely strong commitment to poverty alleviation spend less out of the central budget on infrastructure. No relationship between PCOM and consolidated budget expenditures on infrastructure was found.

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ENDNOTES

1. This report is part of a larger study of the factors that influence broad public expenditure categories: infrastructure, human capital (specifically education and health), and public consumption goods. Consequently, our dependent variable combines government spending on both transportation and communication. Further disaggregation of these and other forms of expenditure on infrastructure would be a useful extension of this research.

2. Consolidated expenditures are conceptually a better measure of a country's outlay on infrastructure, but unitary countries often report only central government expenditures, even if there exist some forms of local spending on infrastructure. Because there are no more observations available for central budget regressions and because there is probably greater consistency between counties in the reporting of central government expenditures than in the reporting of consolidated government expenditures we first report and discuss the results of the central budget regressions, followed by the results of the consolidated budget regressions. Sensitivity analyses for both sets of regressions are reported, and any significant differences in results are noted.

3. International Monetary Fund, *Government Finance Statistics Yearbook* (IMF, Washington, D.C. various years).

4. Given the nature of the dependent variable (per capita government expenditures on transportation and communications), the existing stock variable ideally should at least be expanded to include measures of communication as well as transportation stocks. The 1994 World Development Report contains data on telephone mainlines per 1000 persons, however, these data are available only for a single year (1990) and are incompatible with the present study period (1980-86). Data availability also limited the use of quality-adjusted infrastructure stock variables, but it appears that quality-adjusted stocks may be highly correlated with unadjusted stock variables, at least in the case of paved road mileage. Using data from Table 32 of WDR94, for low and middle-income countries that report both paved road density (km per million) and percent of paved roads in good condition, one can construct a quality-adjusted stock variable (km of good paved roads per million) by multiplying these two variables. The correlation between this quality-adjusted stock variable and the unadjusted stock variable (paved road density) is 0.925.

5. In the conceptual model, although household labor supply is fixed in physical units, it is variable in terms of effective (or efficiency) units. (The household's effective labor supply is enhanced by public expenditures on human resource development, e.g., education and health, as well as private consumption of productivity-enhancing goods such as food). The wage per efficiency unit is determined by competitive forces in the model; unemployment is assumed to equal zero in equilibrium. The fact that labor markets do not necessarily (or even typically) clear in developing countries suggests that the question of

whether labor and public infrastructure are complements or substitutes could alternatively be explored from the demand side utilizing, for example, the ratio of the employed population to the total population. Both data availability and a desire to be consistent with our theoretical model dictated our choice of the labor force participation rate instead. In later work we intended to explore the alternative specification.

6. David Dollar, "Outward Orientation and Growth: an Empirical Study Using a Price-Based Measure of Openness", mimeo. This paper was a background paper for the *World Development Report 1991*. The actual data series used was included in WDR91SD.

7. Both indices, GAS_POL and GAS_CIV were compiled by Raymond Gastil in *Freedom in the World* (Westport: Greenwood Press, various years).

8. We would like to thank Stephen Onyiwu for undertaking the review of documents that served as the basis for the poverty commitment ranking.

9. Table 17 in United Nations Development Program, *Human Development Report 1992* (New York: Oxford University Press, 1992).

10. The full regression results can be obtained from the authors upon request.

11. To some extent, the relatively high R^2s may be attributable to data pooling. This pooling of data over the period 1980-1986 increased our degrees of freedom, which were constrained by missing observations in right hand side variables for low and middle-income countries. For some variables (e.g., the Canning and Fay data on road mileage), five year point interval data were interpolated, giving us more degrees of freedom than "warranted." On the other hand, not all right hand side variables have limited variation; some have fairly substantial recorded variation, even within the limited time period. It seems inappropriate to discard this information by using longer time-period averages. Moreover, the adaption of common time-period averages further reduces sample size. Finally, the cyclical variation that would be reduced or eliminated by time-period averaging is not irrelevant to the questions of interest. For example, if a country runs a deficit (budget or trade), which cannot be indefinitely sustained, we would like to know if infrastructure expenditure suffers as a result. We plan to further explore the influence of cross-sectional versus time-series variation in explanatory variables within a fixed-effects version of the model.

12. As in any regression analysis, causality running from independent variables to the dependent variable cannot be assured. An alternative interpretation of the present result is that counties which spend more per capita on infrastructure are better able to attract external funding. Our model treats external funding as an exogenous factor, but an interesting extension of this line of research would be the specification of a "funding formula" that would allow countries to consider the effects of their behavior on external support.

13. The full regression results are available from the authors upon request.

APPENDIX A: THE MODEL

While this is primarily an empirical study of the determinants of public spending on infrastructure, the structure of the estimated equations is motivated by an underlying model of a dual economy. The analytical framework is a four-sector general equilibrium model, consisting of urban households, urban producers, rural households, and a single government. Total population of the economy (N) is fixed, but households may migrate between the rural and urban sectors in response to perceived differences in utility levels. Since the purpose of this model is to focus on investments in urban infrastructure, vis-a-vis other forms of public expenditure, the urban sector is more completely specified than the rural sector. This specification includes the role of urban land (or space), not only as a source of utility for households and a factor of production for firms, but also as a potential source of property tax revenue for public services.[1]

Urban households consume a domestic composite good, residential space, and a consumption-oriented public good,[2] and provide labor for domestic urban production. Each urban household supplies an amount of labor that is fixed in physical units (e.g., person-years), but variable in terms of effective (or efficiency) units of labor. In particular, the household's effective labor supply per unit of time is enhanced by public expenditures on human resource development such as education, personal health care and public health facilities, as well as by its private consumption of the domestic composite good and residential space. The labor-enhancing effect of human resource outlays (hereafter, simply "training" or T) is consistent with the theory of

1 The property tax generally has played a minor role in LDCs, but the financial strains of structural adjustment, problems of urban congestion, and the escalation of urban land values have stimulated interest in property or development taxes as a means of funding public services in many LDCs. This was an important issue at the Lincoln Institute's Cambridge Conference II (September 1991).

2 Households benefit from G, but cannot select an individual level of consumption. Expenditures on the pure public good are set by government and, hence, regarded as parametric by the household. In the full general equilibrium model, however, this level of consumption-type public goods, as well as the levels of other public expenditures on "training" and "infrastructure" are endogenously determined. In the described form of the model, all public goods are funded by revenues generated by a mix of taxes.

public investment in human capital.[3] The labor-enhancing effect of private noneducational consumption reflects more recent work on household productivity and the influence of better nutrition on health status and labor efficiency.[4] The influence of residential space on household productivity, due to alleviation of overcrowding, has received less attention, but we allow for such effects in the model. The wage rate per effective labor unit (or efficiency wage) is market-determined but parametric to the household. Yet each household's income is endogenous due to the variability in its effective supply of labor.[5] Utility maximizing decisions of the representative urban household result in demands for the domestic composite good and residential space, and an effective labor supply. Each of these behavioral functions, and the resulting indirect utility function, depends on: the market-determined efficiency wage, the price of the composite good, and the price of residential space; parameters of the utility function and the labor-enhancement function; and certain government choice variables including public expenditures on "training" and personal tax rates on wages, domestic consumption, and residential space (property). Although these wages, prices and fiscal policies are parametric to the individual household, each value will be endogenously determined within the complete general equilibrium model.

The urban household's problem is to:

$$\underset{(x,s_r,\mu)}{\text{Maximize}}\ U(x,s_r;G) + \mu\{(1-t_w)w\lambda h[x,s_r;(T+\underline{T})] - (1+t_x)p_x x - (1+t_s)p_{sr}s_r\}, \qquad (1)$$

where choice variables x and s_r are the household's consumption of the domestic composite good and residential space, respectively, and μ is the Lagrange multiplier. Both goods provide utility (U), but they also contribute to the household's effective supply of labor (l), given by the product of the (fixed) physical units of labor supplied (λ) times the labor enhancement function,

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3 See, for example, T.W. Schultz (1975), Jamison and Lau (1982), Psacharopoulos (1985), and T.P. Schultz (1988).

4 Contributions to this literature include: Bliss and Stern (1978), Strauss (1985, 1986), Behrman and Deolalikar (1988), and Deolalikar (1988).

5 The efficiency wage hypothesis, discussed by Liebenstein (1957), Mazumdar(1959), Stiglitz (1976) and others, has been used often in specific applications in labor economics, economic development and macroeconomics.

$h[x,s_r; (T+\mathcal{T})]$. Just as consumption-type public goods (G) enhance household utility, human resource public goods, or "training," enhance the effective supply of labor, each unit of which earns a market wage of w. Unlike G, training is cumulative and thus the current effective supply of labor by the representative household depends on both current human capital expenditures (T) and the existing stock of human capital ($\mathcal{T}$) . The household does not individually choose G or T, but the levels of these public expenditures influence household decisions. Other public instruments that condition household choices are the tax rates on wages (t_w), purchases of the domestic good (t_x), and consumption of residential space (t_s). Household choices are also affected by market-determined prices of the domestic composite good (p_x) and residential space (p_{sr}).

Simple Cobb-Douglas forms for the utility function and the labor enhancement function, or

$$U(x,s_r; G) = Ax^a s_r^b G^c, \quad A > 0, \quad a,b,c \in (0,1), \quad (a+b+c) \leq 1 \tag{2}$$

and

$$h[x,s_r; (T+\mathcal{T})] = Bx^{\alpha} s_r^{\beta} (T+\mathcal{T})^{\gamma}, \quad B > 0, \quad \alpha,\beta,\gamma \in (0,1), \quad (\alpha+\beta) < 1, \tag{3}$$

yield demand functions of the form:

$$x^* = [Z_1 Z_2^{(1-\beta)} Z_3^{\beta} (T+\mathcal{T})^{\gamma}]^{1/(1-\alpha-\beta)} \tag{4}$$

$$s_r^* = [Z_1 Z_2^{\alpha} Z_3^{(1-\alpha)} (T+\mathcal{T})^{\gamma}]^{1/(1-\alpha-\beta)} . \tag{5}$$

Using these expressions in the labor enhancement function also gives the household's effective supply of labor:

$$l^* = \lambda h^* = \lambda [Z_1^{(\alpha+\beta)} Z_2^{\alpha} Z_3^{\beta} (T+\mathcal{T})^{\gamma}]^{1/(1-\alpha-\beta)} , \tag{6}$$

where, in each of the above behavioral functions:

$Z_1 = [(1-t_w)w\lambda B]/(a+b)$; $Z_2 = [a(1-\beta)+b\alpha]/[(1+t_x)p_x]$; and $Z_3 = [a\beta+b(1-\alpha)]/[(1+t_s)p_{sr}]$.

Note that "training" (T) provided by the public sector not only has a positive effect on the supply of effective labor [$\partial(l^*/\partial T > 0$ in (6)], but through the enhancement of earnings it also affects the household's consumption of domestic goods (x^*) and residential space (s_r^*). The consumption public good (G) does not directly alter the demand or effective labor supply behavior, but does affect the equilibrium level of utility of the urban household, given by the indirect utility function:

$$U^* = A[\, Z_1^{a+b}\, Z_2^{a(1-\beta)+b\alpha}\, Z_3^{a\beta+b(1-\alpha)}\, (T+\underline{T})^{\gamma(a+b)}\,]^{1/(1-\alpha-\beta)}\, G^c. \tag{7}$$

Since this level of utility is compared to the (exogenous) level of utility for rural households [$\underline{U}(Y_r,A_r)$, where Y_r is rural income per household and A_r is the level of rural public assistance], the government's provision of both T and G may influence the distribution of population between sectors. These behavioral functions for urban households (4-7), along with the behavioral functions of other key sectors, are ultimately used to construct the conditions for general equilibrium in the economy.

Urban firms combine units of effective labor, nonresidential space, and private capital to produce the domestic composite good, however, production is enhanced by public expenditures on infrastructure. Competitive profit-maximization, under conditions of diminishing returns to scale in private inputs, yields demands for private inputs, output supply, and the indirect profit function. Each behavioral function depends on: market-determined values of the product price, the efficiency wage, the price of nonresidential space, and the rental price of capital; parameters of the production function; and government choices of a property tax rate and a level of expenditures on infrastructure. Other government instruments (t_w, t_x, G, T), which were applied to households, indirectly affect the representative firm's behavior through their influence on market wages and prices.

The urban firm's problem is to:

$$\underset{(l,s_n,k)}{\text{Maximize}}\ \Pi(l,s_n,k;\, I) = p_x x[l,s_n,k;\, (I+\underline{I})] - wl - (1+t_s)p_{sn}s_n - rk, \tag{8}$$

where choice variables l, s_n, and k are the firm's inputs of effective units of labor, nonresidential space, and private capital, respectively. Output of the domestic composite good (x) depends not only on these three private inputs, but also the sum of current period public spending on infrastructure (I) and the existing stock of infrastructure ($\underline{I}$). The firm cannot individually select the level of infrastructure, but its output (x) is augmented by this public good, as indicated by the production function, $x[l,s_n,k; (I+\underline{I})]$. Wage and sales taxes, which were levied directly on households, do not enter the firm's profit function, but will influence the market price of the domestic good (p_x) and the market wage (w) in the full general equilibrium model. Private capital is elastically supplied to the firm at a fixed rental rate (r). Besides infrastructure (I), the other public policy instrument that directly influences production decisions is the rate of property taxation (t_s) on nonresidential space.

A Cobb-Douglas production function with diminishing returns to private inputs, or

$$x[l,s_n,k; (I+\underline{I})] = Cl^{\delta}s_n^{\varepsilon}k^{\phi}(I+\underline{I})^{\rho}, \quad C > 0, \quad \delta,\varepsilon,\phi,\rho \in (0,1), \quad (\delta+\varepsilon+\phi) < 1, \tag{9}$$

yields input demand functions of the form:

$$l^* = [\, p_x C(I+\underline{I})^{\rho}\, Z_4^{1-\varepsilon-\phi}\, Z_5^{\varepsilon}\, Z_6^{\phi}\,]^{1/(1-\delta-\varepsilon-\phi)} \tag{10}$$

$$s_n^* = [\, p_x C(I+\underline{I})^{\rho}\, Z_4^{\delta}\, Z_5^{1-\delta-\phi}\, Z_6^{\phi}\,]^{1/(1-\delta-\varepsilon-\phi)} \tag{11}$$

$$k^* = [\, p_x C(I+\underline{I})^{\rho}\, Z_4^{\delta}\, Z_5^{\varepsilon}\, Z_6^{1-\delta-\varepsilon}\,]^{1/(1-\delta-\varepsilon-\phi)}, \tag{12}$$

where, in each of the above behavioral functions,

$Z_4 = (\delta/w)$; $\quad Z_5 = [\varepsilon/(1+t_s)p_{sn}]$; $\quad$ and $\quad Z_6 = (\phi/r)$;

Substitution of (10-12) into the production function and the profit function give the firm's supply function and indirect (maximum) profit function:

$$x^* = [\, p_x^{\delta+\varepsilon+\phi}\, C(I+\underline{I})^{\rho}\, Z_4^{\delta}\, Z_5^{\varepsilon}\, Z_6^{\phi}\,]^{1/(1-\delta-\varepsilon-\phi)} \tag{13}$$

$$\Pi^* = (1-\delta-\varepsilon-\phi)[\, p_x\, C(I+\underline{I})^{\rho}\, Z_4^{\delta}\, Z_5^{\varepsilon}\, Z_6^{\phi}\,]^{1/(1-\delta-\varepsilon-\phi)}. \tag{14}$$

These behavioral functions for urban firms (10-14) enter into the general equilibrium conditions for the full model.

Also of interest in the sub-model of the urban firm is the dependence of the indirect (maximum) profit function (14) on the level of public infrastructure. The partial derivative of this function with respect to I gives the marginal profit to the individual firm due to incremental outlays on public infrastructure -- in effect, a private firm's demand function for public infrastructure. The individual firm's willingness-to-pay for public infrastructure is given by the expression:[6]

$$\partial\Pi^*/\partial I = \rho[\, p_x\, C(I+\underline{I})^{\delta+\varepsilon+\phi+\rho-1}\, Z_4{}^{\delta}\, Z_5{}^{\varepsilon}\, Z_6{}^{\phi}\,]^{1/(1-\delta-\varepsilon-\phi)}. \quad (15)$$

This willingness to pay is positive but decreases with I (i.e., $\partial^2\Pi^*/\partial I^2 < 0$) if $(\delta+\varepsilon+\phi+\rho) < 1$.

Finally, it should be noted that the number of urban firms (N_f) is assumed to be endogenously determined by the condition: $\Pi^* - \underline{\Pi} = 0$. If equilibrium profits in the urban sector (Π^*) are below some "outside norm" ($\underline{\Pi}$), determined perhaps by investment opportunities in world financial markets, firms will dissolve their capital and exit the domestic market. This capital flight tends to reduce the supply of domestic output and the demand for urban labor and urban nonresidental space. Exit continues until the resulting increase in domestic product price and decreases in factor prices restore the profits of remaining firms to the outside norm.

Rural households play a rather passive role in this predominantly urban model. The total number of households in the economy is fixed (N), but the urban/rural composition (N_u and $N_r = N-N_u$) is endogenous. Rural sector activities are assumed to provide a fixed level of utility ($\underline{U}$), which in turn depends on income per household in the rural sector (Y_r) and various forms of rural public assistance (A_r). If the common level of utility (U^*) enjoyed by urban households (given by the indirect utility function) exceeds $\underline{U}$, rural-to-urban migration occurs, bidding up urban residential and commodity prices and driving urban wages down until the difference between urban

6 The aggregate demand for infrastructure is obtained by vertically summing these individual marginal profit functions (assuming I is noncongestible); congestion effects will reduce this total willingness-to-pay.

and rural utility levels vanishes. The opposite occurs if urban utility levels fall below $\underline{U}$. In this model, then, the rural sector serves primarily as a potential (but finite) source of urban population change, with the equilibrium link between rural and urban utility levels endogenously determining the rural/urban distribution of population. In evaluating investments in infrastructure or other public goods, it is important to consider the potential effects of such investments on the distribution of population and labor between the urban and rural sectors. This limited portrayal of the rural sector provides the necessary mechanism, without unduly complicating the model.

Government has a variety of policy instruments: current expenditures on infrastructure (I), training (T) and a consumption-oriented pubic good (G); and tax rates on wages (t_w), domestic consumption (t_x) and both residential and nonresidential space (t_s). The more complete form of the model requires government to select an instrument mix, subject to the restriction that total public expenditures including rural assistance ($I+T+G+A_r$) less total endogenous revenues from wage, consumption and property taxes, and exogenous revenues from other miscellaneous sources (M) and external assistance (E) not exceed some specified (perhaps zero) deficit target (D). The model can be used to explore a variety of government objectives, including: maximization of domestic output (or output per capita, since population of the economy is exogenous); maximization of the aggregate demand for labor by urban firms; maximization of the efficiency wage; or even some weighted welfare function of these alternative goals. Altering the government objective obviously will affect the optimal mix of instruments.

Government is assumed to:

$$\text{Maximize } \Omega(I,T,G,t_w,t_s,t_x) + \psi\{ N_u[t_w w l^* + t_x p_x x^* + t_s p_{sr} s_r^*] + N_f t_s p_{sn} s_n^* + M + D + E - A_r - I - T - G\}, \quad (16)$$

where Ω is the general objective function of the government, ψ is a Lagrange multiplier, M is miscellaneous revenues from sources other than wage, sales and property taxes, D is the current deficit (debt-funded revenue), E is the level of external assistance, A_r is rural public assistance, and l^*, x^*, s_r^*, s_n^* are given by the earlier behavioral functions from the household and producer choice problems. Note that these imbedded behavioral functions are sensitive to the government's choice of spending levels and tax rates, making the government's objective function a rather complex expression, even though several elements of government behavior (M,D,E,A_r) are taken as exogenous in this form of the model.

General equilibrium in this model incorporates not only the optimizing behavior of individual agents (households, firms, and government), but also clearance of several key markets (domestic product, urban labor, and urban space). Population distribution is determined by the earlier mentioned equilibrium condition between urban and rural levels of household utility, and the number of urban firms is determined by a similar condition requiring equilibrium profits to equal some level available from other forms of private investment. Direct endogenous variables of the model include: the efficiency wage; prices of the domestic product and urban space (separate prices for residential and nonresidential space if allowable-use zoning is incorporated); public expenditures on infrastructure, training, and a consumption-oriented public good; tax rates on wages, consumption and property; and numbers of urban households, rural households, and urban firms.

General equilibrium requires simultaneous solution of a system of 14 nonlinear equations. These conditions include: the 7 first-order conditions defining the government's optimal behavior (one for each of the 6 fiscal instruments and for the Lagrange variable, ψ); market clearance conditions for the domestic product, urban labor, nonresidential space, residential space; equality of urban and rural utility levels; equality of domestic profits and the "outside norm;" and an "adding up" constraint on population. The fourteen primary endogenous variables in this system are:

p_x: domestic product price

w: efficiency wage

p_{sn}: price of nonresidential urban space

p_{sr}: price of residential urban space

N_f: number of urban firms

N_u: number of urban households

N_r: number of rural households

I: public expenditures on infrastructure

T: public expenditures on training (human resources)

G: expenditures on consumption-oriented public goods

t_w: tax rate on wage earnings

t_s: tax rate on urban space (residential and nonresidential)

t_x: tax rate on consumption of the domestic product

ψ: marginal contribution of external assistance (E) to the specified objective of government (Ω).

Once determined, equilibrium values of these endogenous variables may be substituted back into behavioral functions of the submodels to obtain an even more complete profile of the economy (secondary endogenous variables include consumption patterns of the urban household, factor demands and output level of the urban firm, source-specific revenues of government, etc.). Changes in any of the parameters of the model will generally result in new equilibrium values of both primary and secondary endogenous variables.

Empirical forms are motivated by this general equilibrium model. While a variety of reduced form equations are implied by the model, the ones of particular interest to the present study are those associated with government expenditures on infrastructure (I), human capital or "training" (T), and consumption-oriented public goods (G). Any parameter or exogenous variable of the model potentially appears in each of these reduced form equations. Of particular interest to this study are three classes of exogenous variables: (1) a vector of characteristics (V) defining the particular economy; (2) measures of the level and composition of external assistance (E); and (3) variables which might reflect government priorities or objectives (O). Detailed descriptions of dependent and independent variables are provided in the text.

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