

INFRASTRUCTURE INVESTMENT AND INFLATION IN SAUDI ARABIA

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Introduction

The possibility that the resulting supply-side effects of public-sector investment in infrastructure can reduce inflationary pressures has long intrigued economists. Tersely put, increases in investment in infrastructure, while perhaps inflationary in the initial construction stage, may ultimately result in reductions in the price level through the elimination of bottlenecks and the subsequent increase in the supply of goods and services. In particular, investment in such areas as transportation and energy, thereby reducing the costs of commercial production, appear to have the potential of being particularly effective in this regard. It follows that if a stable relationship between increases in infrastructure and reductions in the cost of pro-

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duction exist, the public sector in many developing countries would have a powerful tool at its disposal to achieve high growth with only limited inflationary pressures.

Interestingly enough, despite the compelling attractiveness of the infrastructure-led development strategy, no country case studies had been effected until recently.¹ Using regression analysis for data for 1969, Rosser found a good case could be made for concluding that infrastructure investment had led to reduced inflationary pressures in Saudi Arabia. A close examination of Rosser's study indicates that his analysis was narrowly focused on reductions in the cost of living associated with essentially subsidized credits to the housing and agricultural sectors. In fact, Rosser's measure of "infrastructure" consists solely of loans made by the Real Estate Development Fund (REDF) and the Saudi Arabian Agricultural Development Bank. The Real Estate Development Fund, however, does not really invest in what is traditionally referred to as infrastructure; rather, as its name suggests, it is largely responsible for funding a substantial portion of individual and commercial housing.²

Estimates of the impact of the approximately 140,000 REDF loans granted during the second plan period (1975-80) indicate that they were significant in ending the housing and rent shortage which developed during the early part of the second development plan period. Between 1977 and 1979 rental costs dropped by 30 percent, largely due to the impact of REDF loans.³

The Saudi Arabian Agricultural Development Bank makes essentially interest-free loans to subsidize farmers whose output is, in turn, sold at prices several times lower than the cost of production. That the cost of living falls with increases in the volume of subsidized houses and food is hardly surprising. Few development economists would, however, consider investment in housing or agriculture as expansions in the stock of infrastructure. Nor would they consider this a particularly wise strategy for achieving sustained long-run noninflationary expansion in output.

The purpose of this note is to take Rosser's argument a step further and demonstrate that, while his definition of infrastructure leaves much to be desired, his findings concerning the positive impact of infrastructure are essentially correct. Having both the

willingness and the means to undertake a program of infrastructure-led development, Saudi Arabia provides an ideal case study for examining the effectiveness of a development strategy built around massive increases in infrastructure.⁴

In actuality, the Saudi authorities have spent more on infrastructure in the last 15 years (1970-1985) than any nation in history over a similar time span. Since 1970, when the country initiated its first development plan, through the completion of the Third Plan in 1985, the government had allocated approximately 375 billion riyals (Rls) to development infrastructure. (During most of this period the exchange rate was around 3.5 Rls to the U.S. dollar.)

Impact of Increased Infrastructure on Domestic Inflation

Operationally, the impact of infrastructure on inflation in Saudi Arabia is modeled by a blending of the Hirschman/Voigh views concerning the impacts stemming from the infrastructure development process.⁵ If infrastructure plays a role similar to that envisaged by Hirschman and Voigh, we should expect to find the resulting potential increase in the rate of return on various commercial activities inducing the private sector to increase its level of real output. While likely to be inflationary in the short run, over time, this should result in a closing of the inflationary gap created by the infusion of purchasing power associated with the construction phase of the infrastructure expansion program.

However, the new, higher level of output may, depending on the way it is financed, result in an overexpansion of the money supply neutralizing the longer-run anti-inflationary effect of the induced expansion of infrastructure.

Operational Definitions

Much of the confusion as to the role of infrastructure in the development process stems from the fact that few countries have statistics as to the value and composition of their stock of infrastructure. Saudi Arabia is no exception. In particular, official Saudi data on government investment contain both infrastructural and noninfrastructural type expenditures. Conceivably, the cost-reducing effect of

the infrastructure component of government investment could be offset by the (inflationary) crowding out of private-sector activity that stems from the noninfrastructural component. To avoid these potential problems, it is necessary to separate out and estimate the independent effects of the different categories of public investment. Since the raw data do not allow these distinctions to be made, one way of getting around this problem is to develop alternative proxies for infrastructural and noninfrastructural components. The basic assumption underlying these proxies is that infrastructure investment is an ongoing process that moves slowly over time and cannot be changed very rapidly. In this regard, the trend in real public-sector investment (GINPLT) has been taken as representing the long-term or infrastructural component and argued that this should have a positive effect on gross real private investment; deviations from the trend (GINPDLT) are assumed to represent noninfrastructural investment.

Structure of the Model

Incorporating the considerations just outlined, the model used to examine the differential impact of government expenditures on inflation in Saudi Arabia involved the following factors.

1. The inflationary impact of noninfrastructural components of government investment was estimated by including a short-run measure of transitory government investment (GEXPT). For the trend in government investment, this consisted of each year's deviation from the trend.

2. The impact of world price movements on the Saudi Arabian price level was included to reduce any biases stemming from the period of world inflation occurring in the mid- to late 1970s. Since Saudi Arabia does not publish figures on the price of imports, this variable was proxied by the International Monetary Fund's industrial countries' export price index. This index was lagged one year (INFWL) to allow changes in import prices to work themselves through the domestic cost structure.

3. Inflation is also assumed to be a function of inflationary expectations (NODFE). This factor was proxied by regressing the

nonoil price deflator on its value in the previous year, and using each year's predicted value in the regression equation.

4. The potential impact of excess money balances on the nonoil price deflator was treated by including the money supply (M1) in the regression equation.

5. The reduction in inflationary pressures stemming from increased real supplies of goods and services was proxied by nonoil gross domestic product (NOXNP).

Finally, to test the generality of the model, regressions were performed using both the nonoil gross domestic product deflator (NODF) and the consumer price index (CPI).⁶

Summarizing the above in equation form (with expected signs):

$$\text{INF} = f [\text{INFE}(+), \text{INFWL}(+), \text{M1}(+), \text{NOXNP}(-), \text{TGINP}(- +), \text{GINPT}(+)]$$

where

INF = the nonoil gross domestic product (GDP) deflator (and the consumer price index);

INFE = expected increase in the nonoil GDP deflator (and the consumer price index);

INFWL = export price index of the industrialized countries (lagged one year);

M1 = the money supply as defined by the International Monetary Fund;

TGINP = the trend in government investment (infrastructure); and

GINPT = transitory government investment (noninfrastructure) depicted by deviations from the trend.

If the assumptions concerning infrastructure are correct, one would expect the sign on infrastructure investment to be negative, whereas it is assumed that the transitory component is either insignificant or has a positive impact on inflation through the crowding out of private-sector productive activity.

Empirical Results

$$\begin{aligned}
 \text{NODF} = & 0.85 \text{ NODFE} + 2.51 \text{ INFWL} + 0.002 \text{ M1} - 0.13 \text{ NOXNP} \\
 & (7.60) \quad (5.11) \quad (0.27) \quad (-0.65) \\
 & - 0.07 \text{ TGINP} - 0.02 \text{ GINPT} - 0.42 \text{ RHO} \\
 & (-2.56) \quad (-0.04) \quad (-2.18) \\
 & R^2 = 0.999; F = 2770.5; DW = 2.13 \quad (1)
 \end{aligned}$$

where

RHO = the serial correlation factor;

R^2 = the coefficient of determination;

F = the F statistic; and

DW = Durbin-Watson statistic.

For the consumer price index:

$$\begin{aligned}
 \text{CPI} = & 0.81 \text{ CPIE} + 6.62 \text{ INFWL} - 0.32 \text{ NOXNP} \\
 & (9.52) \quad (4.95) \quad (-0.73) \\
 & -1.92 \text{ TGINP} - 0.08 \text{ GINPT} - 0.37 \text{ RHO} \\
 & (-2.72) \quad (0.06) \quad (-1.79) \\
 & R^2 = 0.995; F = 696.2; DW = 2.01 \quad (2)
 \end{aligned}$$

with CPIE the expected consumer price index.⁷ Several interesting patterns appear in the results.

6. It is clear that infrastructure investment in Saudi Arabia has reduced inflationary pressures. This conclusion holds for both the nonoil GDP deflator and the consumer price index.

7. The transitory (noninfrastructural) component of government investment does not appear to have contributed to inflationary pressures over the period examined (1960-1985).

8. World inflation has been imported into Saudi Arabia and has contributed significantly to increases in the nonoil GDP deflator.

9. Contrary to the situation found in many other countries, the money supply does not appear to have made an independent contribution to inflation.

As a basis of comparison, it is of some interest to determine what inflationary impact, if any, has been produced by government con-

sumption. Here, one would anticipate that increases in government consumption, by contributing to excess demand (but not supply), would—if anything—increase the overall inflationary pressures in the country. As with investment, the trend in government consumption (TGCNP) was used to measure the longer-run impact, and deviations from the trend (GCNPT) were used to capture the inflationary pressures stemming from transitory increases in government consumption. Adding these considerations to our basic model yielded:

$$\begin{aligned} \text{NODF} = & 0.96 \text{NODFE} + 2.13 \text{INFWL} - 0.09 \text{NOXNP} + 0.10 \text{TGCNP} \\ & (29.63) \quad (10.09) \quad (-6.72) \quad (7.26) \\ & + 0.27 \text{GCNPT} - 0.05 \text{TGINP} - 0.03 \text{GINPT} - 0.83 \text{RHO} \\ & (3.25) \quad (-2.49) \quad (-1.76) \quad (-7.24) \\ & R^2 = 0.999; F = 18537.0; DW = 2.71. \end{aligned} \quad (3)$$

$$\begin{aligned} \text{CPI} = & 0.68 \text{CPIE} + 4.68 \text{INFWL} - 0.09 \text{NOXNP} + 2.03 \text{TGCNP} \\ & (7.87) \quad (3.88) \quad (-1.85) \quad (3.06) \\ & + 0.34 \text{GCNPT} - 1.23 \text{TGINP} + 2.41 \text{GINPT} - 0.37 \text{RHO} \\ & (0.73) \quad (-2.06) \quad (1.69) \quad (-1.87) \\ & R^2 = 0.997; F = 1228.4; DW = 2.45. \end{aligned} \quad (4)$$

In general, therefore, government expenditures are not uniform in their inflationary impacts, with government consumption tending to increase inflationary pressures and government investment in infrastructure tending to reduce these pressures. Clearly, the changing composition of government expenditures over time toward consumption and away from infrastructure will have implications for the country's future rate of inflation.

The timing of infrastructure's contribution to price stability is also of considerable interest, i.e., how much time elapsed between the post-1973/74 investment boom and the point when infrastructure investment ceased to be inflationary and began to reduce overall inflationary pressures?

Using the linear trend (GINPLT) as the measure of infrastructural investment, and starting with the 1960-1975 time interval, this transition appears to have begun around 1979.

Impact of infrastructure on inflation, 1960-1975:

$$\begin{aligned} \text{NODF} = & 0.89 \text{ NODFE} + 0.11 \text{ INFWL} + 0.06 \text{ M1} - 0.05 \text{ NOXNP} \\ & (2.84) \quad (0.12) \quad (3.23) \quad (-6.00) \\ & + 0.09 \text{ GINPLT} - 0.12 \text{ RHO} \\ & (2.54) \quad (-0.42) \\ & R^2 = 0.999; F = 1183.1; DW = 2.14. \end{aligned} \quad (\text{a})$$

Impact of infrastructure investment on inflation, 1960-1976:

$$\begin{aligned} \text{NODF} = & 0.31 \text{ NODFE} + 1.26 \text{ INFWL} + 0.06 \text{ M1} - 0.06 \text{ NOXNP} \\ & (2.46) \quad (2.41) \quad (3.60) \quad (-6.70) \\ & + 0.12 \text{ GINPLT} + 0.43 \text{ RHO} \\ & (3.31) \quad (1.76) \\ & R^2 = 0.999; F = 1918.0; DW = 1.66. \end{aligned} \quad (\text{b})$$

Impact of infrastructure on inflation, 1960-1977:

$$\begin{aligned} \text{NODF} = & 0.83 \text{ NODFE} + 3.46 \text{ INFWL} - 0.01 \text{ M1} - 0.08 \text{ NOXNP} \\ & (8.09) \quad (14.92) \quad (-1.19) \quad (-8.61) \\ & + 0.14 \text{ GINPLT} - 0.48 \text{ RHO} \\ & (4.89) \quad (-2.09) \\ & R^2 = 0.999; F = 5240.1; DW = 2.43. \end{aligned} \quad (\text{c})$$

Impact of infrastructure on inflation, 1960-1978:

$$\begin{aligned} \text{NODF} = & 0.74 \text{ NODFE} + 3.26 \text{ INFWL} - 0.002 \text{ M1} - 0.07 \text{ NOXNP} \\ & (11.21) \quad (21.75) \quad (-0.43) \quad (-8.31) \\ & + 0.14 \text{ GINPLT} - 0.44 \text{ RHO} \\ & (4.71) \quad (-1.89) \\ & R^2 = 0.999; F = 8865.0; DW = 2.43. \end{aligned} \quad (\text{d})$$

Impact of infrastructure on inflation, 1960-1979:

$$\begin{aligned} \text{NODF} = & 0.50 \text{ NODFE} + 2.67 \text{ INFWL} + 0.06 \text{ M1} - 0.08 \text{ NOXNP} \\ & (5.10) \quad (9.14) \quad (6.92) \quad (-5.14) \\ & - 0.15 \text{ GINPLT} + 0.78 \text{ RHO} \\ & (-4.41) \quad (5.01) \\ & R^2 = 0.999; F = 498.9; DW = 2.23. \end{aligned} \quad (\text{e})$$

Impact of infrastructure on inflation, 1960-1980:

$$\begin{aligned} \text{NODF} = & 0.33 \text{ NODFE} + 3.01 \text{ INFWL} + 0.06 \text{ M1} - 0.05 \text{ NOXNP} \\ & (2.82) \quad (8.33) \quad (5.10) \quad (-2.88) \\ & - 0.13 \text{ GINPLT} + 0.62 \text{ RHO} \\ & (-2.88) \quad (3.27) \\ & R^2 = 0.999; F = 617.5; DW = 1.74. \end{aligned} \quad (\text{f})$$

Impact of infrastructure on inflation, 1960-1981:

$$\begin{aligned} \text{NODF} = & 1.03 \text{ NODFE} + 3.08 \text{ INFWL} - 0.02 \text{ M1} - 0.03 \text{ NOXNP} \\ & (7.99) \quad (8.06) \quad (-1.26) \quad (-1.81) \\ & -0.01 \text{ GINPLT} - 0.62 \text{ RHO} \\ & (-0.26) \quad (-3.41) \\ & R^2 = 0.999; F = 3432.2; DW = 2.34. \end{aligned} \quad (\text{g})$$

Impact of infrastructure on inflation, 1960-1982:

$$\begin{aligned} \text{NODF} = & 0.92 \text{ NODFE} + 2.86 \text{ INFWL} - 0.006 \text{ M1} - 0.03 \text{ NOXNP} \\ & (16.06) \quad (9.48) \quad (-0.96) \quad (-1.56) \\ & - 0.05 \text{ GINPLT} - 0.68 \text{ RHO} \\ & (-1.38) \quad (-4.09) \\ & R^2 = 0.999; F = 4655.5; DW = 2.24. \end{aligned} \quad (\text{h})$$

Impact of infrastructure on inflation, 1960-1983:

$$\begin{aligned} \text{NODF} = & 0.86 \text{ NODFE} + 2.43 \text{ INFWL} + 0.003 \text{ M1} - 0.004 \text{ NOXNP} \\ & (12.37) \quad (7.39) \quad (0.40) \quad (-2.22) \\ & - 0.09 \text{ GINPLT} - 0.47 \text{ RHO} \\ & (-2.22) \quad (-2.42) \\ & R^2 = 0.999; F = 3234.9; DW = 2.23. \end{aligned} \quad (\text{i})$$

Impact of infrastructure on inflation, 1960-1984:

$$\begin{aligned} \text{NODF} = & 0.85 \text{ NODFE} + 2.47 \text{ INFWL} + 0.003 \text{ M1} - 0.007 \text{ NOXNP} \\ & (12.97) \quad (8.55) \quad (0.40) \quad (-0.56) \\ & - 0.08 \text{ GINPLT} - 0.48 \text{ RHO} \\ & (-2.51) \quad (-2.56) \\ & R^2 = 0.999; F = 4071.6; DW = 2.33. \end{aligned} \quad (\text{j})$$

Impact of infrastructure on inflation, 1960-1985:

$$\begin{aligned} \text{NODF} = & 0.84 \text{ NODFE} + 2.48 \text{ INFWL} + 0.003 \text{ M1} - 0.01 \text{ NOXNP} \\ & (12.62) \quad (8.40) \quad (0.36) \quad (-0.96) \\ & - 0.07 \text{ GINPLT} - 0.42 \text{ RHO} \\ & (-2.65) \quad (-2.17) \\ & R^2 = 0.999; F = 4322.5; DW = 2.26. \end{aligned} \quad (\text{k})$$

It is fairly safe to conclude that infrastructure began to play an important role in price stabilization around 1979, and that it has contributed to the government's anti-inflationary objectives throughout the 1980s.

Conclusions

It is hoped that this note has confirmed a number of tentative assertions first made by Rosser concerning the potential role infrastructure could have in reducing inflationary pressures in Saudi Arabia. This strategy of infrastructure-led development began paying fairly high dividends around 1979 and has enabled the country to sustain relatively high rates of real output growth in an environment of low to nonexistent inflation.

Ultimately, however, the results presented here raise more questions as to the wisdom of the country's development strategy than perhaps they answer.

It is not at all clear, for example, how long past infrastructure investments will be able to continue reducing inflationary pressures, given the reduction since the mid-1980s in infrastructure investments brought on by both the completion of many major projects and the reduction in expenditures of this type necessitated by the post-1982 decline in oil revenues. With the current downturn in economic activity, some of the country's industrial establishments are working at much less than full capacity. The demands on infrastructure are thus declining over time and are expected to continue so for the foreseeable future. The resulting rise in unit costs may thus produce an inflationary effect sufficient to offset any potential benefits provided by the existing stock of infrastructure.

NOTES

¹J. Barkley Rosser, Jr., "Infrastructure Investment and Inflation in Saudi Arabia," *Economic Forum*, summer 1983, pp. 143-47.

²Adnan M. Abdeen and Dale Shook, *The Saudi Financial System* (New York: John Wiley, 1984), p. 142.

³Ibid.

⁴See Robert Looney and P. C. Frederiksen, "The Evolution and Evaluation of Saudi Arabian Economic Planning," *Journal of South Asian and Middle Eastern Studies*, winter 1985, pp. 3-19.

⁵A. O. Hirschman, *The Strategy of Development* (New Haven, Connecticut: Yale University Press, 1958) and F. Voigh, "The Tasks of Modern Transport Science," *International Journal of Transport Economics*, April 1974, pp. 255-62.

⁶Estimations were made using the Cochrane-Orcutt iterative estimation procedure. This procedure transforms the data (generating a variable RHO) to eliminate serial correlation. Details of this procedure are given in Robert Hall, *Time Series Processor (TSP), Version 4.0* (Stanford, California: Hall and Hall, 1985).

⁷The expected consumer price index was computed by regressing the consumer price on its value for the previous year.
