The impact of public *investment on private* investment in Brazil, *1947-1990*

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This article analyses the impact of public investment on private investment. Apart from purely ideological aspects, two opposing interpretations may be distinguished with regard to the relationship between these variables. The first is that there is competition between public and private investment, so that the former "crowds out" the latter. The second is that public investment is complementary to private investment in so far that, by generating positive externalities, it creates favourable conditions for the latter. In view of the relative scarcity of empirical studies on this matter, this study deals with the case of the Brazilian economy in the period from 1947 to 1990. Its main conclusions are that private investment is indeed crowded out by public investment in the short term, but in the long term the cointegration vector coefficients indicate that these two variables complement each other.

I

Introduction

Many economists maintain that reducing the size of the State would be a good thing for society as a whole, since they consider that public investment is less efficient than private investment. They also assert that the State should not compete with the private sector for the use of productive resources. In view of the scarcity of physical and financial resources, they say, if the government appropriates these resources this would, at least in the short term, have a negative effect on private investment. Furthermore, public intervention can raise prices and interest rates in the economy, thus reducing the private sector's disposition to invest (Buiter, 1977; Sundararajan and Thakur, 1980; Ram, 1986). The crowding-out of private investment is shown in the IS-LM model.[1] It should be noted that because it limits itself to short-term impacts, this model omits the long-term effects (Buiter, 1977 and 1980).

However, there are also those who maintain that public investment can have a complementary effect (crowding-in) with respect to private investment, especially when it is made in the areas of infrastructure and the provision of public goods. Barro (1990) shows that public investment has a strong impact on the marginal productivity of private capital and labour.

Another argument in favour of public investment is that the State is more willing to make higher-risk investments than the private sector. In the developing economies, sectors which require large volumes of initial capital and long lead times are considered to be of high risk (Dixit and Pindyck, 1994). It would be hard for the private sector to make such investments, not only because of the risk but also because of the limited size of the secondary securities market. It would be difficult for the incipient financial sector of those countries to finance long-term projects that require a large volume of resources.

Through its investment, the government can act in an anti-cyclical manner to reduce fluctuations in aggregate demand and uncertainty in the economy. Another effect which is noted in the economic literature is that the government increases the aggregate demand of the economy by creating a market for goods produced by the private sector. By increasing aggregate demand, public investment can have a positive impact on society's expectations with regard to the behaviour of that variable. An increase in those expectations will lead to a rise in private investment. Thus, the government investment would have two positive impacts: firstly, it would generate demand for the private sector, and secondly, it would raise future expectations with regard to aggregate demand, giving rise to an increase in private investment (Sundararajan and Thakur, 1980).

In the economic literature, four methodologies are identified for approaching the question of crowding-out versus crowding-in: computable general equilibrium models, IS-LM model estimates, models of the impact on the supply side, and estimates of the investment function. The appendix to this article gives a summary of the published studies using these methodologies.

Computable general equilibrium models not only make it possible to estimate the effect of public investment on private investment but also permit the study of its effect on the other macroeconomic variables and income distribution. This methodology also makes it possible to estimate the result of the impact of public investment on private investment on the basis of various sources of financing, such as increased taxes, money issue, an increase in the public debt, etc. Pardahan, Ratha and Sarma (1990) use this working methodology, but note that the computable general equilibrium model leaves out possible long-term impacts.

Another interesting methodology in the literature on this subject is the estimation of an IS-LM type model: the studies using this methodology suffer, however, from the fact that they use econometric techniques which can give rise to skewed results.

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[1] There are two types of effects: direct crowding-out, which is the reduction of the physical resources available to the private sector, and indirect crowding-out, which takes place through the increase in interest rates and prices. See Buiter, 1977 and 1980.

The so-called supply-side impact estimates the effect of public investment on total factor productivity. One of the first studies in this area was that of Ram (1986), followed by Aschauer (1989). It may be noted that Barro (1990) has developed a model in line with the "new growth theory", thus consolidating this line of research which has given rise to a number of empirical studies.

Finally, the impact of public investment on private investment can be estimated on the basis of investment theories. In the present article it was decided to estimate the investment function, for which purpose an attempt has been made to compare Jorgenson's neoclassical theory with the theory of irreversible investment in conditions of uncertainty. It may be noted that there are few empirical studies which seek to identify a relation between irreversible investment in conditions of uncertainty and the impact of public investment on private investment.

More specifically, the present article seeks to estimate the behaviour of private investment as a function of the aggregate product, of the interest rate and of public investment for the Brazilian economy in the period 1947-1990. It analyses not only the short-term impacts but also the long-term ones, estimating an autoregressive model with distributive lags (ADL). The long-term equilibrium for this type of estimate gives the static solution. The results indicate that in the short term (error correction model) there is substitution between public and private investment, whereas in the long term the relation expressed in the cointegration vector indicates that the impact of public investment on private investment is positive.

The article is divided into four sections. After the introduction (section I), the empirical formulation and the theoretical bases used are described in section II, the econometric results are presented in section III, and section IV contains the conclusions.

II

Theoretical structure

First of all, a brief review will be made of the economic theory on investment, after which the empirical formulation used in this article will be set forth. Jorgenson (1963) developed a model in the neoclassical tradition in which enterprises seeking to maximize their gains equate the marginal productivity of capital with its utilization cost. Adding together the capital needs of each enterprise, this gives the total amount of capital desired by society. A theoretical framework with microeconomic bases is thus constructed for determining the desired capital. In this context, an enterprise has optimum accumulation when the marginal productivity of its capital equals its utilization cost. The notion of the utilization cost of the capital comes from the idea that most of the capital belongs to the enterprise, which therefore does not pay rent for using it. However, the use of this capital nevertheless has a cost for the enterprise, measured by the opportunity cost of maintaining it. The depreciation and variation in the value of the capital goods belonging to the enterprise must be included as part of the utilization cost. This cost will determine the optimum accumulation of capital. The interest rate plus the variation in the value of the capital stock (variations in price and depreciation) must be equal to the marginal contribution of the capital to the enterprise. This is the main conclusion of Jorgenson's model. It assumes the existence of adjustment costs, so that current investment would not be immediately in line with the desired level. It generally postulates a symmetrical adjustment cost, that is to say, the enterprise would incur the same costs for investing and disinvesting.

Among the components which determine investment, there are two components, namely expectations and the uncertainty of the economy, which are not incorporated in Jorgenson's formulation. Moreover, the assumption of symmetrical adjustment costs would appear to have little empirical backing, since disinvestment is seen to have a higher cost for an enterprise than investment. The notion of irreversibility arises from such criticisms. Once an enterprise has made an investment, that capital is not reversible without major difficulties.

The reasons for this are as follows: i) poorly developed secondary markets for capital goods; ii) adverse selection in the quality of capital goods, and iii) specific types of capital for specific enterprises.

As the secondary market for capital goods is limited, especially in the developing countries, the enterprise will have to bear heavy costs if it wishes to disinvest the capital it possesses.

Adverse selection is connected with the question known in the literature as the "lemons problem".[2] As the owner of the capital good has more information on it than the possible buyer and there are capital goods of different qualities, the cost of disinvestment for the enterprise will also be high. Moreover, as the market price is determined by the average quality of goods, suppliers of capital would be reluctant to offer a good of higher quality than the average. Thus, when selling a capital good on the secondary market an enterprise could incur heavy costs.

With regard to specific capital, it is assumed that the enterprise uses capital goods specifically adapted to its production line. If it wishes to dispose of such goods, the purchasers will have to make modifications in order to adapt the equipment to another type of production line. A common example in the literature is that of the iron and steel industry. Consequently, the assumption of asymmetrical adjustment costs would appear to be the most appropriate for modelling private investment (Dixit and Pindyck, 1994; Pindyck, 1993).

Thus, if we assume the extreme case of an irreversible investment in conditions of uncertainty, it is reasonable that enterprises will become more cautious when making investments, even in a favourable environment, because in an adverse future they could find themselves with an excess of capital which they cannot reduce. Ultimately, the enterprise must include in its strategic planning the possibility of postponing investment in the present period in order to make it in a later period. This analytical methodology explains why, even in a favourable economic environment, some enterprises prefer not to invest. Dixit and Pindyck (1994) cite the case of the drop in interest rates in the United States in 1991 and 1992 as a good example of this situation. In spite of that drop, there was practically no change in the level of investment. These authors suggest that the drop in interest rates also meant a reduction in the opportunity cost of postponing the investment and awaiting more favourable economic conditions. They also maintain that the liquid effect (of a reduction in interest rates) is weak and often ambiguous.[3]

The main contribution of the studies by Dixit and Pindyck (1994) is the notion that if, in conditions of uncertainty and irreversible investment, there are possibilities of postponing a project, then this information should be incorporated in the calculation of the investment decision. If this is done, the response of investment to changes in the economic environment displays a smoother trajectory, with fewer fluctuations than that based on the traditional theory.[4] Thus, the reasons for situations in which the economic environment is favourable but the rate of investment shows little variation are to be found in the theory of Dixit and Pindyck (1994). The example of the drop in interest rates in the United States appears to be one of these cases.

In the present study, as in the study by Rocha and Teixeira (1996),[5] private investment is considered a dependent variable whose behaviour is explained by the short-term interest rate, the aggregate product and public investment. Thus, the functional formulation used is as follows:

$$I_{private} = f(Y,r,I_{public})$$

The aggregate product, *Y*, includes the investment function as the demand expectations of entrepreneurs. A positive relation between the aggregate product and private investment is expected. The nominal interest rate, *r*, measures the utilization cost of capital. If it has a negative coefficient, this provides empirical evidence in favour of the neoclassical theory of Jorgenson. Likewise, a very small value for the interest rate coefficient, or a statistically insignificant coefficient, would provide empirical evidence in favour of the theory of irreversible investment in conditions of uncertainty. Public investment can have

[2] The idea of adverse selection was proposed by Akerlof (1970). That author analysed the used car market in the United States and showed that imperfect information and automobiles of dubious quality have a strong effect on used car prices. In that country, automobiles of dubious quality are known as "lemons", so that the problem of adverse selection also came to be known as the lemons problem.

[3] Dixit and Pindyck (1994), p. 14. These authors also maintain that the stability of interest rates is more important than their actual level. If the aim is to stimulate investment, a policy of eliminating undesirable and unnecessary fluctuations in interest rates should be pursued.

[4] In this respect, see Caballero (1993).

[5] The data were obtained from the GDP, the information on private and public investment was taken from the historical series of the Brazilian Institute of Geography and Statistics (IBGE), and the data on investment by State enterprises were provided by the Getúlio Vargas Foundation. Interest rates were taken from Ronci, 1991.

either a negative or a positive effect. Depending on the sign of the coefficient, this determines the impact of the public sector on private investment. If the coefficient is positive it indicates a relation of complementarity, while if it is negative it reflects a relation of substitution.

III

Econometric results

The results of the Dickey-Fuller test to determine whether the series are stationary are given in table 1.[6] The first column in this table shows the variables analysed. The second gives the values of the expanded Dickey-Fuller test (t-adf), and the third column shows the number of lags in the first difference. The last two columns give the values of the observed t statistic for the coefficients of these lags and the respective levels of significance (t-prob). The criterion for the selection of the lags for this test was the level of significance of the coefficient for each of them, in line with the methodology suggested by Doornik and Hendry (1994).

As may be seen, the only statistically significant lag was that of the GDP with one period of lag, since t-prob was 0.003. It was therefore necessary to analyse the expanded Dickey-Fuller test (t-adf), which in this case did not provide any evidence that the GDP series was stationary (t-adf = -1.6718 > $t\text{-adf}_{critical}$ = 3.957). For the other variables, the Dickey-Fuller test without lags is sufficient to reject the hypothesis that the series are stationary.

The same test was then used to analyse whether or not the differences in the series whose results are given in table 2 are stationary or not. These statistical procedures rejected the hypothesis that the difference series are not stationary. It is therefore concluded that GDP, private investment, public investment and the nominal interest rate are first-order integrals, since the primary differences are stationary. This procedure for determining the nature of the integral series is suggested in Enders (1995).[7]

TABLE 1
Dickey-Fuller test for the series logarithm [a]

Variables	t-adf	Lag	t-lag	t-prob
Log GDP	-1.5330	2	0.9458	0.3504
Log GDP	-1.6718	1	3.142	0.0033
Log GDP	-2.2860	0	-	-
Log private investment	-1.1477	2	0.77385	0.4439
Log private investment	-1.1070	1	-1.2818	0.2077
Log private investment	-1.406	0	-	-
Log public investment	-1.4655	2	0.6244	0.5362
Log public investment	-1.5323	1	0.10748	0.9150
Log public investment	-1.5588	0	-	-
Log Tx interest	0.41525	2	-1.5847	0.1216
Log Tx interest	-0.36457	1	-0.91304	0.3670
Log Tx interest	-1.0046	0	-	-

[a] The critical values of the distribution calculated by Mackinnon (1991), expanded Dickey-Fuller with constant included, are -2.934 at the 5% confidence level and -3.597 at the 1% level.

TABLE 2
Dickey-Fuller test for the first difference of the series logarithm [a]

Variables	t-adf	Lag	t-lag	t-prob
ΔLog GDP	-2.1228	2	0.78225	0.4392
ΔLog GDP	-1.9917	1	-1.1311	0.2653
ΔLog GDP	-2.9672[b]	0	-	-
ΔLog private investment	-3.0506[c]	2	0.36210	0.7193
ΔLog private investment	3.3158[c]	1	-1.0961	0.2799
ΔLog private investment	-6.3339[c]	0		
ΔLog public investment	-3.1563[c]	2	0.36210	0.7193
ΔLog public investment	-3.4211[c]	1	-1.0961	0.2799
ΔLog public investment	-5.6931[c]	0	-	-
ΔLog Tx interest	-5.8007[c]	2	2.2279	0.0321
ΔLog Tx interest	-5.8508[c]	1	1.3803	0.1756
ΔLog Tx interest	-7.4870[c]	0	-	-

[a] The critical values of the distribution calculated by Mackinnon (1991), expanded Dickey-Fuller with constant included, are -1.949 at the 5% confidence level and -2.621 at the 1% level.
[b] Significant at the 5% level.
[c] Significant at the 1% level.

[6] The logarithm of the series was used; this transform has advantages because the estimated coefficients can be interpreted as elasticities. Various empirical studies have made the same change, as for example Aschauer (1989), Rocha and Teixeira (1996) and Ferreira (1994). The logarithmic transform of the data also makes possible greater stability of the variance, which favours the empirical estimation.

[7] Analysis of the autocorrelation of the series by level and differences was also used, and it was likewise concluded that there was first-order integration.

TABLE 3

Best estimate of private investment, 1948-1990 [a]
(Dependent variable: private investment)

Variables	Coefficient	Standard deviation	t-statistic	t-prob
Log private investment (1) [b]	0.70489	0.092524	7.618	0.0000
Log GDP	2.6629	0.47158	5.647	0.0000
Log GDP (1) [b]	-2.5166	0.48354	-5.205	0.0000
Log public investment	-0.38131	0.087515	-4.357	0.0001
Log public investment (1) [b]	0.45212	0.084599	5.344	0.0000
Trend	0.0069648	0.0033298	2.092	0.0436

[a] R^2 = 0.999818 DW = 2.16 Harvey's R^2 = 0.87870
[b] (1) indicates that the variable is shifted by one period.

Lagrange multiplier for autocorrelation:	F (2.34) =	0.41762	[0.6619]
ARCH 1	F (1.34) =	0.043591	[0.8359]
Normality	χ^2 (2) =	4.5611	[0.1022]
White's heterocedasticity test	F (12.23) =	0.75517	[0.6870]
Ramsey's specification test (RESET)	F (1.35) =	1.9639	[0.1699]

The values in parentheses indicate the *p-value* of the test.

In the present study, it was decided to estimate an ADL.[8] We began with linear regression, using a more global dynamic specification (lags of three periods) in order to identify the dynamics of the relation between the variables. The main conclusions were that only the one-period lag was significant for the analysis; the others were statistically insignificant according to the F test provided by the Pc-Give econometric programme.

The interest rate proved to be insignificant with all the lags, which is evidence in favour of the theory on investment in conditions of uncertainty. This result is also compatible with those found by Rodrigues (1988), Ronci (1991) and Studart (1992). In all these studies, the interest rate has a coefficient with very low or statistically insignificant value. Rodrigues (1988) and Studart (1992) maintain that the availability of credit would be a more important variable for private investment in Brazil. The regression with the best statistical result may be seen in table 3.

The current GDP coefficient is that which showed the greatest impact on private investment. As was to be expected, the sign was positive, which indicates that demand expectations are a relevant variable. The lagged GDP coefficient was negative. However, the liquid effect of demand on private investment is positive.

Lagged private investment had a positive sign, which reflects the irreversibility of investment: in other words, investment made in the preceding period has a positive effect on investment in the present period.[9] It may be noted that this variable was quite significant, with a Student-T value of 7.6. The idea of the irreversibility of investment decisions was strengthened by the trend variable which, although having a very low coefficient, was nevertheless significant at 5%. The value of this coefficient would also appear to indicate private investment aimed at covering the depreciation of the capital stock.

Public investment in the current period has a negative effect on private investment, possibly reflecting competition for the use of the available resources (substitution), whereas public investment in the preceding period has a positive impact on private investment, which suggests the existence of complementarity.

The static equilibrium will determine whether the series are cointegrated, that is to say, whether there is a long-term relation between them. The Pc-Give econometric programme indicates such a relation on the basis of a steady-state dynamic equilibrium condition. It gives the value of the coefficients, as well as a joint test for their significance. The results of the long-term static solution for the regression in question are as follows:

[8] In order to use the model with only one equation, it is assumed that the product and public investment are only weakly exogenous and that there is a cointegration vector.

[9] See Gujarati (1995). This author suggests that the dependent variable, lagged as exogenous in the regression, indicates some friction in this aggregate.

TABLE 4

Result of applying the error correction model, 1949-1990

Variables	Coefficient	Standard deviation	t-statistic	t-prob
	A. *Without dummy variable*[a]			
ΔLog GDP	2.7176	0.30047	9.045	0.0000
ΔLog public investment	-0.38753	0.074176	-5.224	0.0000
ECM (1) [b]	-0.28437	0.061806	-4.601	0.0000
	B. *With dummy variable*[c]			
ΔLog GDP	2.7866	0.27501	10.133	0.0000
ΔLog public investment	-0.42329	0.068706	-6.161	0.0000
i 1954 (dummy variable)	-0.25452	0.085380	-2.981	0.0050
ECM (1) [b]	-0.26179	0.056875	-4.603	0.0000

[a] R^2 = 0.702479; DW = 2.19; Harvey's R^2 = 0.85033
Data criteria: SC = -4.61857; HQ = -4.69719
[b] (1) indicates that the model is de-phased by one period.
[c] R^2 = 0.758869; DW = 1.86; Harvey's R^2 = 0.87870
Data criteria: SC = -4.73972; HQ = -4.84455

Lagrange multiplier for autocorrelation: F (2.36)	=	0.4181	[0.6614]
ARCH 1 F (1.36)	=	0.70956	[0.4052]
Normality χ^2 (2)	=	3.1013	[0.2121]
White's heterocedasticity test F (7.30)	=	0.21539	[0.9790]
Ramsey's specification test (RESET) F (1.37)	=	0.20456	[0.6537]

Log private investment = + 0.4956 Log GDP + 0.2399 Log public investment + 0.0236 Trend

Wald test χ^2 (3) = 2921.1 [0.0000] [10]

The long-term equilibrium solution for the Brazilian economy for the period 1948-1990 indicates that the GDP has a positive impact on private investment of the order of 0.5, while public investment has a positive impact of 0.24 in the long term. In spite of the negative value of the current public investment coefficient, when the long-term effect of such investment is analysed it is noted that the effect is positive. There are two factors which may explain this fact: the impact of public investment on GDP may have a longer lead time, and the complementary effects (crowding-in) may also have longer lead times. A typical example would be the construction of a hydroelectric station or an iron and steel plant which takes several years to give results. These impacts confirm the long-term analysis made by Sundararajan and Takhur (1980) for India, where in the short term government investment has a negative impact on private investment, but in the long term public investment has a positive effect on private sector investment decisions. It may be noted that this long-term effect is omitted in the studies on the Brazilian economy. After noting the cointegration of the variables, it is necessary to estimate the model once again in an abbreviated form, that is to say, to adjust the model for differences, including the lagged error correction mechanism. The abbreviated coefficients showed the adjustment of the economy towards a long-term trajectory. Consequently, these coefficients reflect the short-term impact and not the long-term equilibrium relation (Enders, 1995; Doornik and Hendry, 1994). The adjustment of the error correction model gave the results shown in table 4.[11]

[10] Significant at the 1% level. The value between parentheses indicates the *p-value* of the test.

[11] The unit root tests suggested in Harris (1995) rejected the hypothesis of non-cointegration, while the estimated value for the test was -3.43 and the critical value at 10% is -3.4, which suggests that there is convergence of the model for the long-term solution. When the ECM coefficient is analysed, the unit root tests for this variable confirm the cointegration hypothesis. This fact suggests to us that the economy should converge towards this equilibrium solution, that is to say, it confirms that the variables are cointegrated.

In the error correction model, no lag of the variables was significant except that in the error correction mechanism (ECM). The estimation of the ECM with the current differences has the great advantage that these differences are not correlated with the ECM, in other words, the tests of the significance of the coefficients can be carried out individually without losing efficiency. Furthermore, the coefficients of the current differences represent the short-term impacts with a good empirical adjustment (Hendry, 1995).

As was to be expected, the coefficient of the lagged ECM is negative. This sign of the coefficient represents the adjustment of the model towards the long-term equilibrium, with a value of 0.28.

The above result is in accordance with the results obtained by Rocha and Teixeira (1996); the coefficient of public investment has a negative impact on private investment when the error correction model is adjusted. However, the authors did not analyse the long-term impacts expressed by the cointegration vector, so that their conclusion that there is substitution between public and private investment in Brazil is only correct for the short term. It should be recalled that in the long term private investment responds positively to public investment.

Analysis of the residues standardized by the standard deviation gave an atypical value for 1954, possibly reflecting the situation of relative uncertainty that the Brazilian economy was experiencing during that period. A dummy variable was included for that year, thus improving the adjustment of the data. The dummy variable was significant at the 1% confidence level; the information criteria of Schwarz and Hannan-Quinn gave higher values in the module, as did the R^2 and also Harvey's R^2. The normality tests also improved, while the correlation diagram of the residues points to the conclusion that the residues are "white noise".

The results with the inclusion of the dummy variable (table 4, section B) were as follows: the heterocedasticity tests (ARCH and White) did not reject the null hypothesis for the homocedasticity of the residues, and neither was evidence found in favour of the hypothesis of the autocorrelation of the residues, so that the regression residues would appear to be "white noise"; this fact indicates good adjustment of the data, so that the model seems to be well specified, as reflected in the Ramsey test (RESET).

IV

Conclusions

In short, the results give grounds for concluding that in the case of Brazil:

i) Demand expectations, represented here by the GDP, are the main factor in determining private investment.

ii) The irreversibility of investment decisions was confirmed by the significance of the lagged private investment coefficient.

iii) The theory of investment in conditions of uncertainty was backed up by the fact that the model showed the statistical insignificance of the interest rate coefficient.

iv) Substitution of private investment by public investment was only noted in the short term.

v) The complementarity between private and public investment was brought out by the sign of the coefficient of that variable in the long-term adjustment.

It would be interesting to carry out complementary studies investigating the causal relation between the variables involved in the model, in order to clarify the possible indirect impacts which may exist. It would also be important to make a sectoral disaggregation of public investment in order to identify the mutual impact of the different sectors of the economy.

Nevertheless, the present study does make some useful contributions through its estimation of an investment function based on the theory of irreversible investment in conditions of uncertainty and its analysis of the long-term impact, which is omitted by most empirical studies dealing with Brazil. Private investment in Brazil does not seem to be very sensitive to interest rates, but it does react strongly to demand expectations, represented in this study by the effec-

tive product and public investment. Other possible future projects could involve an analysis of the effect of the financing of public investment and the preparation of a more specific model for the expectations of private agents. The subject is of considerable importance, and there is a great deal of scope for future research.

(Original: Portuguese)

APPENDIX

Summary of studies on private and public investment

Author	Date	Methodology [a]	Country	Impact [b]
Sundararajan and Thakur	(1980)	IF	India	Negative
Sundararajan and Thakur	(1980)	IF	South Korea	Positive
Blejer and Khan	(1984)	IF	Group of countries	Negative
Ram	(1986)	SS	Group of countries	Positive
Rodrigues	(1988)	IF	Brazil	Negative
Aschauer	(1989)	IF	United States	Positive
Musalém	(1989)	IF	Mexico	Positive
Pardahan, Ratha and Sarma	(1990)	CGEM	India	Negative
Greene and Vilanueva	(1991)	SS	Group of countries	Positive
Ronci	(1991)	IF	Brazil	Negative
Ramirez	(1991)	IS-LM	Mexico	Positive
Barro	(1991)	SS	Group of countries	Positive
Sanchez and Lora	(1992)	IF	Colombia	Negative
Shafik	(1992)	IF	Egypt	Positive
Studart	(1992)	IF	Brazil	Negative
Sant'Ana, Rocha and Teixeira	(1994)	IS-LM	Brazil	Positive
Ferreira	(1994)	SS	United States	Positive
Dalamagas	(1995)	SS	Group of countries	Positive
Cashin	(1995)	SS	Group of countries	Positive
Rocha and Teixeira	(1996)	IF	Brazil	Negative
Nazmi and Ramirez	(1997)	IF	Mexico	Negative

[a] The four methodologies identified were:
CGEM: Computable general equilibrium model.
IS-LM: IS-LM type model.
SS: Supply-side impact (through factor productivity).
IF: Estimation of investment function.
[b] Estimated effect of public investment on private investment and/or the product.

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