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A KEYNESIAN (TOBIN'S Q) INVESTMENT FUNCTION FOR THE TURKISH PRIVATE INVESTMENT AND THE COMPLEMENTARITY OF PUBLIC AND PRIVATE CAPITAL†

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Abstract:

This paper has two main aims. First, it attempts to test a Keynesian (Tobin's q) investment function for the Turkish private sector within a dynamic stochastic model framework between the years 1963-85. Second it sets out to compare its results with those of a previous Neoclassical work of a similar track, and concludes that it is the phenomenon of the composition of public capital rather than its method of finance which explains private capital accumulation in the Turkish context.

Özet:

Türkiye'de Özel Sektör İçin Bir Keyneşci (Tobin's q) Yatırım Denklemi Yoluyla Kamu Ve Özel Sektör Kapital İlişkileri

Bu çalışmanın iki temel amacı vardır. Birincisi bir dinamik stokastik model çerçevesinde Türk özel sektörü için bir Keynesci yatırım denklemini 1963-85 yılları için test etmek, ikincisi bu çalışmanın sonuçlarını daha önce yapılan benzeri bir Neoklasik çalışmanın sonuçlarıyla mukayese etmektir. Varılan sonuçlar finans metodundan çok kamu sermayenin kompozisyonun özel sektör sermaye birikimini açıkladığı yönündedir.

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Anahtar Sözcükler: Kamu sermaye harcamaları, özel sermaye, maliye politikası dışlama etkisi.

1. INTRODUCTION

Keynes's original contribution to investment demand theory distinguishes the internal rate of return on various investments projects or assets from the alternative cost of investing, which is the interest rate prevailing in the economy. Put simply, Keynesian investment demand is explained by the relative price of a capital asset, which represents the ratio of the demand price of capital over the supply price of capital. As Arslan (1999) explains, this ad-hoc determination of investment demand was later challenged by neo-Keynesians such as Tobin in the `60s and `70s. As a result, a new concept of Q theory emerged. Q theory, in its simple form, posits that Keynesian investment demand function is directly related to the gap between the marginal productivity of capital (MPK) and the cost of capital. Q is then a function of capital stock, labor demand, real interest rate, and depreciation rate. The structure of the preceding Keynesian model rules out a perfect market in the existing capital stock in which firms can engage in trading their own existing capital. Instead, they add to their capital stock at a finite rate per unit of time.

The theoretical foundations of this weak ad-hoc Keynesian investment demand theory were later enhanced and rationalized by economists such as Eisner, Strotz, Lucas, Gould, and Treadway, all of whom incorporated the concept of the costs of adjustment into the neoclassical profit maximizing behavior of a firm (Sargent, 1979).

However, in traditional Keynesian macroeconomic models, scant attention is given to the analysis of any possible differential economic impacts of various forms of public spending. This is primarily due to the fact that the demand-side oriented nature of the Keynesian model does not allow for a consideration of such effects on private capital accumulation; if anything, it would be a result of government purchase of goods and services, rather than the composition of such spending (as opposed to tax-financed), which might either induce an ex post crowding-out of private investment through raising real interest rates, or which might crowd-in private investment via a rise in output to permit higher private and public expenditure (Eisner, 1986). Bailey (1971), however, considered the possibility that households might internalize the future taxes implicit in current public debt issuance, while at the same time differentiating between public consumption and public investment spending. He worked out government spending multipliers under differing sets of assumptions, such as households regarding public consumption as a perfect substitute for private consumption. In this instance, an increase in government consumption induces an ex ante decrease in private consumption in such a way that the output effect of the public spending is nil.

David and Scadding (1974) also emphasized the possibility of such an ex ante crowding out of private by public expenditure. Their argument was that a rise in government bond issuance crowded out an equal amount of private investment, since deficit finance is regarded as public investment and public investment substitutes for private capital spending. Further, tax-financed government spending was treated as government spending, crowding out an equivalent amount of private consumption. Thus, the result was that fiscal policy had no effect on the level of aggregate demand. Certainly, this argument is consistent with the postulation of an "ultrarational" consumer only if public capital expenditures are, as a rule, debt-financed.

Thus, the private investment demand function of a Keynesian type suggested by Tobin (Tobin's q) may be expressed as (Sargent, 1979)

$$IP = MPK / (r - \delta - p^{\bullet} / p)$$

where :

IP	=	private investment
MPK	=	Marginal Productivity of Capital
r	=	nominal interest rate
δ	=	depreciation rate
$p^{\bullet} / p$	=	expected inflation

This lies in close conformity with the production structure, which in essence means that the capital stock is assumed to be fixed in the short run. Therefore, investment demand can be taken as a constant elasticity function of the ratio of the marginal product of capital MPK (profit per unit of capital) to the cost of capital (real interest rate).

On the other hand, the marginal product of private capital may be expressed as

$$MPK = f(K, IG, UC)$$

where :

K	=	Capital stock
IG	=	Government investment

UC = Capacity utilization

Thus, private investment demand is estimated via the simultaneous solution of the above stated equations.

2. MODEL ESTIMATION

In our empirical analysis, since real interest rates are negative for most of the observation period of 1963 and 1985, we are forced to adopt a semi logarithmic form of investment demand function; that is,

$$\log(IP) = \beta_0 + \beta_1 \log(MPK) + \beta_2 (RRD)$$

where :

$\beta_1, \beta_2, \beta_3$	=	estimated coefficients
RRD	=	real interest rate (being equal to the difference between nominal interest rate and expected inflation, namely, $RD - \Delta \log\ PGNP$)
RD	=	nominal interest rate
PGNP	=	GNP deflator

However, we need to point out further explanations as to determining the private capital formation process for the financially repressed Turkish economy. By financial repression, we mean holding official interest rates, most particularly deposit rates of interest, below their equilibrium levels. Under this disequilibrium interest rate regime, excess demand for bank loan prevails (credit rationing) since the firms are unable to finance all planned investment at the official lending rate. So we note that the investment demand above is planned investment. In this case, the difference between planned and effective investment demand needs to be explained and incorporated into the above equation. Our method of tackling this problem is to justify that the difference mentioned is rationalized by the phenomena of the spill over effects of disequilibrium in the credit market (For a clear empirical exposition and incorporation of disequilibrium in the loan market into investment demand, see Bank of Finland (BOF3) Quarterly Model of the Finnish Economy, 1985).

Therefore, real credit availability is an important determinant in the effective investment demand equation and included below as a ratio to GDPFC.

$$\log(\mathrm{IP}) = \alpha_0 + \alpha_1 \log(\mathrm{MPK}) + \alpha_2(\mathrm{RRD}) + \alpha_3 \log\left(\frac{\mathrm{RCRP}}{\mathrm{GDPFC}}\right)$$

where :

RCRP = real domestic credit to the private sector
GDPFC = real GDP at Factor Cost

Thus, the reduced form of the structural model is given by the following and the reader is referred to Arslan (1999) for a discussion of technicalities involved in estimating such a system of equations.

$$\mathrm{Log(IP)} = \beta_0 + \beta_1 \sum_{i=-2}^{0} \log(MPKRO(i)) + \beta_2(RRD) + \beta_3 \log\left(\frac{RCRP}{GDPFC}\right) + \beta_4 CU1 + \beta_5 D787980 + \in$$

$$\mathrm{MPK} = \beta_6 + \beta_7 \mathrm{RIG} + \beta_8 \mathrm{CU2} + \beta_9 \mathrm{D77} + \beta_{10} \mathrm{D8485} + \in_2$$

where :

IP = Private Investment,
RIG = the ratio of public investment to GNP,
MPK = the marginal product of capital
MPKRO = the marginal product of capital, inclusive of depreciation rate,
RRD = real interest rate,
RCRP = real domestic credit to the private sector,
GDPFC = real GDP at Factor Cost,
CU1 = the deviation of GNP from its longterm linear trend,
CU2 = the deviation of the average GNP per capital stock from its longterm linear trend,
D787980 = dummy variable having a value of 1 for the years 1978, 1979 and 1980 and 0 for the rest of the sample period,
D77 = dummy variable having a value of 1 for the year 1977 and 0 for the rest of the sample period,
D8485 = dummy variable having a value of 1 for the year 1984 and 1985 and 0 for the rest of the sample period,
$\in$ = i.i.d random error or disturbance term.

3. DATA CONSTRUCTION AND SOURCES

The methodology and sources/compilation of data utilized in this study are the same as those adopted in our previous line of work, namely Arslan (1993, 1999). In an effort to compile the necessary data for our macroeconomic model, not only did we face such difficulties as the unavailability, unreliability, and constant revision of data common to most developing nations, but also those of establishing accounting consistency among data provided from a variety of sources. Thus, we chose to follow the meticulous methodology adopted on this subject by an expert, Demirors (1988).

In order to construct the database for our model, we have benefited immensely from the master database of the United Nations Department of Research and Policy Analysis (DRPA). In addition to the NIPA account data of the U.N., we utilized statistics from country-based sources such as the Turkish State Planning Organization (SPO) and State Institute of Statistics (SIS), as well as from the Statistical Annex of the Country Reports of the World Bank (WB).

We would like now to give a brief overview of how we reconciled data from various sources or accomplished accounting consistency.

In carrying out the aggregation of production data into seven sectors, the starting step was the 64-sector I-O table prepared by the SIS for use in preparing the Fourth Five-year Plan (1973-1978). This I-O table was aggregated into ten sectors by the SPO and into fifteen sectors by Celasun (1981), who attempted to reconcile I-O accounts with available NIPA accounts. These aggregation schemes are further reconciled by the WB researchers for utilizing both I-O data and NIPA data for their CGE model for Turkey. Consequently, a thirteen-sector aggregation scheme is adopted. (See Appendix to the World Bank Country Report (1983) for a thorough exposition of the reconciliation of the various classifications of sectors adopted by above researchers and institutions).

In our model, we considered a seven-sector aggregation scheme on the basis of the above thirteen-sector aggregation scheme of the WB, as we generated value added for seven sectors from the NIPA account provided by four different sources (SPO, SIS, U.N., and the WB Country Reports) to be consistent with our seven-sector aggregation of the 1973 I-O table. We had difficulties in reconciling GDP at both constant 1968 prices and current prices obtained from the production side and the expenditure side of the various above sources. The reason for this difficulty arises from the fact that, while data for the production side on both current and constant 1968 prices were available for the period following the launching of the planning era in 1963, on the expenditure side data were available only in current prices. However, some estimated figures were available for the constant 1968 prices. These were introduced into the expenditure side by double-checking the data from the four sources cited earlier.

On the cost composition of value added, only wages and capital consumption allowances were given explicitly at current prices; hence, we were supposed to generate the profit rate utilized in our investment equation.

The first task was to generate capital stock. Aggregate capital stock is generated by using the perpetual inventory method. The most significant part of this stage is to determine the right level of the capital stock for the benchmark year. To our knowledge, most of the researchers who dealt with building a sort of I-O or CGE model tried to obtain capital stock on an ad hoc assumption of a reasonable ratio of capital to output. Subsequently, on that basis capital stock levels are produced in proportion to output growth.

Accordingly, we utilized the approach of an SPO expert (Temel, 1982) who made one serious attempt to generate capital stock figures at 1980 prices. The less painful task in the process was to convert this capital stock at 1980 prices into that of 1968 prices. As a result, we were able to obtain conclusive real profit rates. On the wage side, we did not use any given daily wage level from the country-based sources such as census data, Social Insurance Institute data, etc. Instead, we generated wages as an average yearly wage income by dividing labor employment compensation figures by aggregate employment figures.

In conclusion, despite all the difficulties faced in the compilation of our database, accounting consistency is to a large extent established as a basis for empirical analysis.

4. ESTIMATION RESULTS

On this basis, the estimation of the reduced form is undertaken by full information maximumlikelyhood methods to take into account the overriding restrictions implicit in the structural model. However, it needs to be emphasized that the more appropriate interpretation to give to the results of statistical tests involving these cross equation restrictions is simply in terms of assessing the adequacy of the structural model in explaining the data rather than a direct test of an exactly specified theoretical model. Table 1 displays the results of full information maximumlikelyhood estimation for the sample period of 1963-85.

Table 1: FIML Estimation Results

Coefficients	Value	T-stat
b_0	1.455	3.93
b_1	0.903	2.41
b_2	- 0.72	- 2.23
b_3	0.501	2.58
b_4	1.2 E-06	3.02
b_5	0.017	2.80
b_6	0.180	9.90
b_7	0.920	5.70
b_8	0.190	3.20
b_9	- 0.020	- 2.00
b_{10}	0.028	3.50

Single Equation Statistics

	RSQ	SER	DW
IP	0.74	0.003	1.3
MPK	0.88	0.004	1.6

where :

RSQ = R Square
SER = Standard Error of Regression
DW = Durbin-Watson statistic

5. MODEL PERFORMANCE

The estimated model is simulated dynamically over the sample period to see its predictive ability (ex-post dynamic simulation). There are two steps involved here. First, while suppressing the error terms, the dynamic simulation is performed to solve for the endogenous variables of the model, given their actual "historical" values, the values of the estimated coefficients, and the initial values of the lagged dependent variables. Second, in order to determine how the simulated model tracks with the historical data, a comparison between the actual and the simulated "predicted" data is made. This is regarded as a useful test of the validity of the model. For that purpose, Table 2 is constructed to show the results of three most common measures of predictive accuracy. These are RMSE (%), Root Mean Square Percentage Error; ME (%), Mean Absolute Percentage Error; and STD, Standard Deviation of the Simulation. If ex post predictions are perfect, then these three measures are zero. (For more information on this, the reader is asked to refer to Arslan (1999)). However, the RMSE (%) is considered a best measure compared with the other two and its results indicate the model performance remains within acceptable limits.

Table 2: Results of Ex Post Simulation

Variable	RMSE (%)	ME (%)	STD
IP	11.23	- 0.41	11.68
MPK	3.34	0.149	0.347

6. POLICY SIMULATION

The dynamic policy simulation experiment of our statistically estimated model analyses the impact on the endogenous variable, as others are kept unchanged. The difference between the controlled and simulated solutions is shown by the duration and degree of sustained impact. Table 3 displays the results of a 10% reduction in public investment over the course of the five year simulation period of 1980-85.

Table 3: Effect of a 10% Reduction in Public Investment

	Variable	1 st year	2 nd year	3 rd year	4 th year	5 th year
IP	Simulated	16660	17361	18585	20004	21385
	Actual	16899	17812	18650	19972	21040
	Difference	- 239	- 181	- 65	32	345
	% Difference	- 1.41	- 1.02	- 0.35	0.16	1.64
MPK	Simulated	0.289	0.295	0.300	0.317	0.325
	Actual	0.296	0.300	0.299	0.314	0.318
	Difference	- 0.07	- 0.05	0.001	0.003	0.007
	% Difference	- 2.365	- 1.667	0.334	0.955	2.201

Investment demand as another factor in this upturn in GDPFC shows also an upward trend in the last years of the simulation period. Although the profitability is low in the short run, it improves in the long run because a depletion of aggregate capital stock induced by government investment outgrows a fall in total profits, hence, this causes profit per unit of capital stock to go up. Also, another stimuli in private investment demand is the increasing ratio of real credit available to the private sector in proportion to aggregate demand.

7. CONCLUSION

As Arslan (1993) shows, the historically observed close parallels between the public and private capital accumulation in the studied period point to a high degree of complementarity between the two in the Turkish Economy.

Over the years, our concerted efforts to explain this phenomenon have utilized both Neoclassical and Keynesian approaches, and our published and unpublished works lead us to conclude that the composition of public capital plays the most crucial role in determining private investment. Consequently, neoclassical investment models incorporating this factor in their structure appear to be better suited for the task, for the demand oriented nature of the Keynesian framework does not readily lend itself into an analysis of differential impacts of public expenditure to capture their long term effects on private capital accumulation. In essence, by raising the marginal productivity of private capital over the long haul, public investment into infrastructure exerts more influence in the process and crowds in private investment. Two arguments could be made to support this rationale. First, in the case of an expansionary public investment policy, the Keynesian model responds in a manner that results in a complete crowding out of private investment, whereas the Neoclassical model employed by Arslan (1999) displays a lesser degree of a crowding out of private investment. Second, in terms of the model performance criterion (RMSE %), the former performs (IP=11.23) poorer than the latter (IP=5.62), whereby departing more significantly from the historically observed private investment values. As a result, we feel justified, on precautionary grounds, to conclude that it is the composition of public capital (i.e public investment in infrastructure), rather than its method of finance, that explains the private sector behavior in the Turkish context.

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