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WORKING PAPER 84-81

TOWARD A MODEL OF THE OFFICE BUILDING SECTOR

BY
KENNETH T. ROSEN

GRADUATE SCHOOL OF BUSINESS ADMINISTRATION

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UNIVERSITY OF CALIFORNIA, BERKELEY

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April 1984

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Research was supported by the Center for Real Estate and Urban Economics at the University of California at Berkeley.

I. Introduction

High rise office buildings represent large capital outlays in very competitive markets. Investment and development decisions require careful market analysis to assure sufficient demand to lease the office space at rental rates which will make the venture financially attractive. Present methodology for analyzing future commercial real estate market conditions can at best be said to be inadequate. This methodology relies on concepts such as "market absorption" rates and "normal" vacancy rates. These concepts usually rely on accounting type and trend line techniques to provide forecasts of space demand. Rather than a model which can be used to statistically test and forecast office space demand, supply, rents, and vacancy rates, the traditional analysts have merely derived careful accounting identities which are unsatisfactory for forecasting purposes.

II. A Supply-Demand Model of Office Space - Theoretical View

An alternative methodology for forecasting the key variables in the office space market is to develop a statistical model of supply and demand. The key variables that need to be forecasted are the stock of office space (in square feet), the flow of new office construction (in square feet), the vacancy rate (in percent), and the rent for office space (net rent per square foot).

Office space can be viewed as one input in the production process which has as its final output in most cases financial, information, management, and administrative services. Thus, the

demand for office space can be forecasted using models similar to those used to forecast the demand for capital goods. The most commonly used type of model for this purpose is a stock adjustment model.

The stock adjustment model assumes that the desired stock of office space is a function of employment in the key service producing industries and the price of office space. Equation (1) shows the stock demand in functional form.

$$(1) \quad OSQFT_t^* = f\ (EMP_{it},\ R_t/P_t)$$

where:

$OSQFT_t$ = Square feet of occupied office time - t

EMP_{it} = Employment type - i, time - t

R_t/P_t = Rent time - t/Overall Price Level time - t

The key to implementing this formulation is to accurately model the components of the demand for office space, the price adjustment mechanism for office space, and the supply response of developers.

Employment growth in the finance, insurance, and real estate activities is the key dynamic variable on the demand side. Employment growth is in turn a function of the demand for employees in a particular city. The demand for employees is thus a function of real GNP growth, corporate profits, and the growth of the particular industry mix in the metropolitan area. The employment equation can be written as follows:

(2) $EMP_{it} = f\ (GNP_t,\ Profit_t,\ I_{it})$

where:

GNP_t = GNP time - t

Profit = Profit Corporate Sector time - t

I_{it} = Growth in demand for services industry - i, time - t

The rental price adjustment mechanism in the office building sector follows the pattern of other real estate markets. The first response to a change in demand is an adjustment in vacancy rates. The vacancy rate adjustment then affects rents in a non-linear fashion. Rents rise (fall) more rapidly the further the actual vacancy rates moves from the "optimal" vacancy. Equation (3) shows this relationship.

(3) $R_t = f\ (V_t - V_t^*,\ P_t)$

where:

R_t = Change in net office rents

V_t^* = Optimal vacancy rate

V_t = Actual vacancy rate

P_t = Change in Overall Price Level

Actual and optimal vacancy rates are in turn defined in equations (4) and (5).

(4) $V_t = (SQFT_t - OSQFT_t)/SQFT_t$

where:

$SQFT_t$ = Total supply of office space

$OSQFT_t$ = Occupied office space

(5) $V_t^* = f\ (i,\ R^e_t)$

where:

i_t = Interest rates

R^e_t = Expected rent levels

Thus, higher interest rates lower optimal vacancy rates, while higher expected rent increases raise optimal vacancy rates as suppliers of space attempt to profit maximize.

The final sector of the model is of course the supply of new office space. The supply of new office space is a function of the expected profitability of holding the space over its economic life. This in turn is a function of expected rents, construction costs, interest rates, and tax laws affecting commercial real estate. Equation (6) shows the flow of new construction and equation (7) the stock identity for all office space supplied.

(6) $\Delta SQFT_t = f\ (V_t,\ R^e_t,\ CC_t,\ i,\ TAX)$

(7) $SQFT_t = SQFT_{t(-1)} + \Delta SQFT_t$

To summarize, the office building model analyzes the stock and flow of new office space, the rent for office space, the vacancy rate and occupancy rate of existing space. In turn, employment growth in the key services industries and overall economic activity and interest rates are fundamental determinants of the demand for space.

III. Empirical Estimation for the San Francisco Office Market

Portions of the model outlined in the previous section were estimated using historical data from 1961 - 1983 on occupied stock, vacancy rates, rents, total stock, and new construction of office space in San Francisco. Equations (1), (3), and (6) are the key estimated relationships in the office building model. Equations (4) and (7) are identities. Equation (5) was not estimated, the optimal office building vacancy rate was assumed to be seven percent, the actual average rate for the 1961 - 1983 period. Equation (2) also was not estimated although for a forecasting version of the model, an estimated equation would clearly be desirable. Actual employment in the Finance, Insurance, and Real Estate (FIRE) categories was used in equation (1). The historical data for vacancy rates, rents, and new construction are shown in Figures (1) - (3).

Equations (1), (3), and (6) were all estimated using ordinary least squares regressions. Looking first at the occupied stock equation, we find a strong positive relationship between the occupied stock of office space and FIRE employment. Real rents show a strong negative correlation with occupied office space. The overall regression, shown below, explains most of the variance in the occupied stock over time.

$$\text{(1E)}\quad \text{Log (Ostock)} = \underset{(22.18)}{-17.82} + \underset{(28.4)}{1.86} * \text{Log (EMPL)} - \underset{(2.81)}{.178}\ \text{Log (Rent/p)}$$

$\bar{R}^2 = .977$ 1962 - 1983

t - statistics in parentheses

FIGURE 1

SAN FRANCISCO OFFICE SPACE TIME SERIES, 1959-1983

AVERAGE RENT

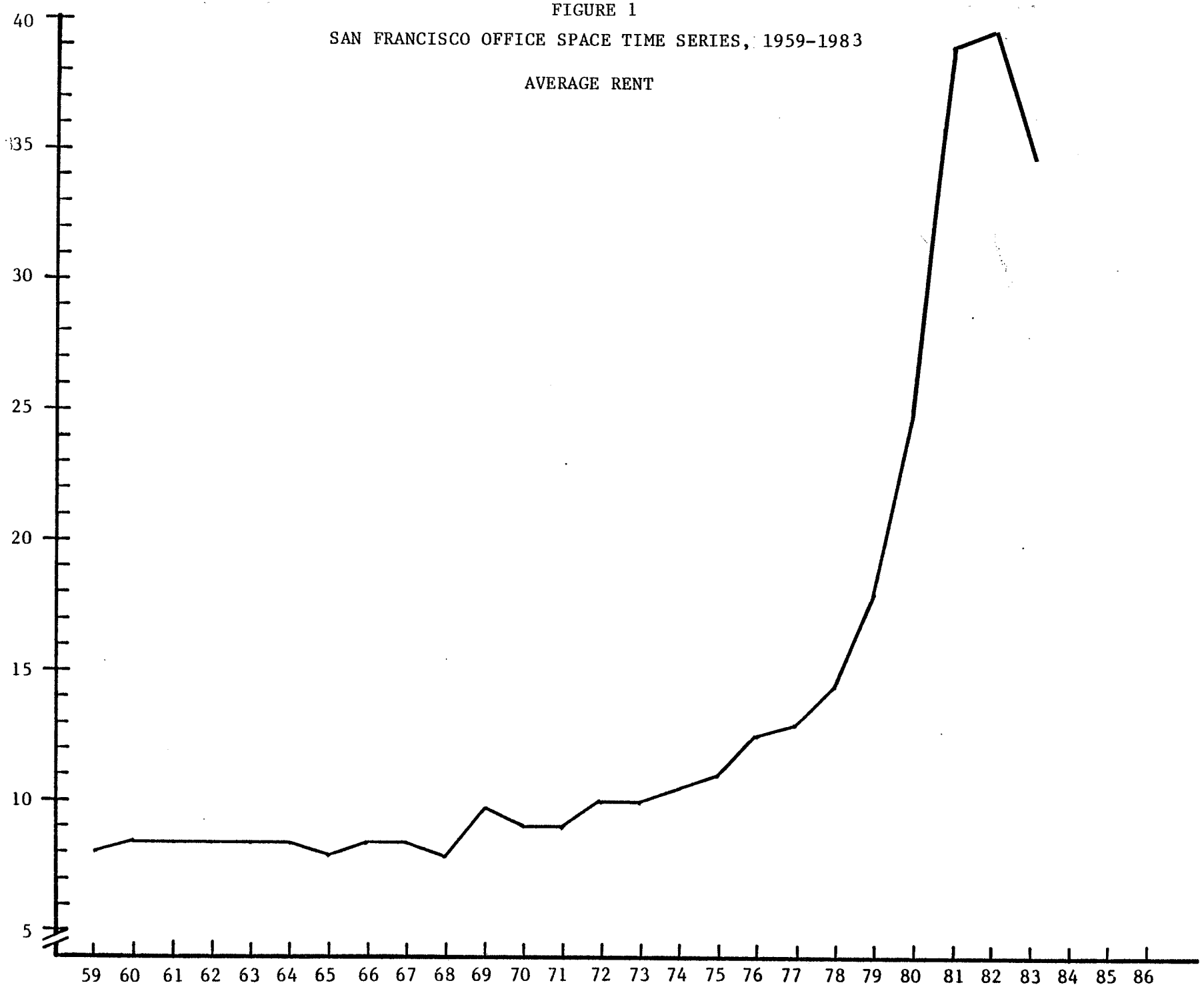


FIGURE 2

SAN FRANCISCO OFFICE SPACE TIME SERIES, 1959-1983;

VACANCY RATE

(Percent)

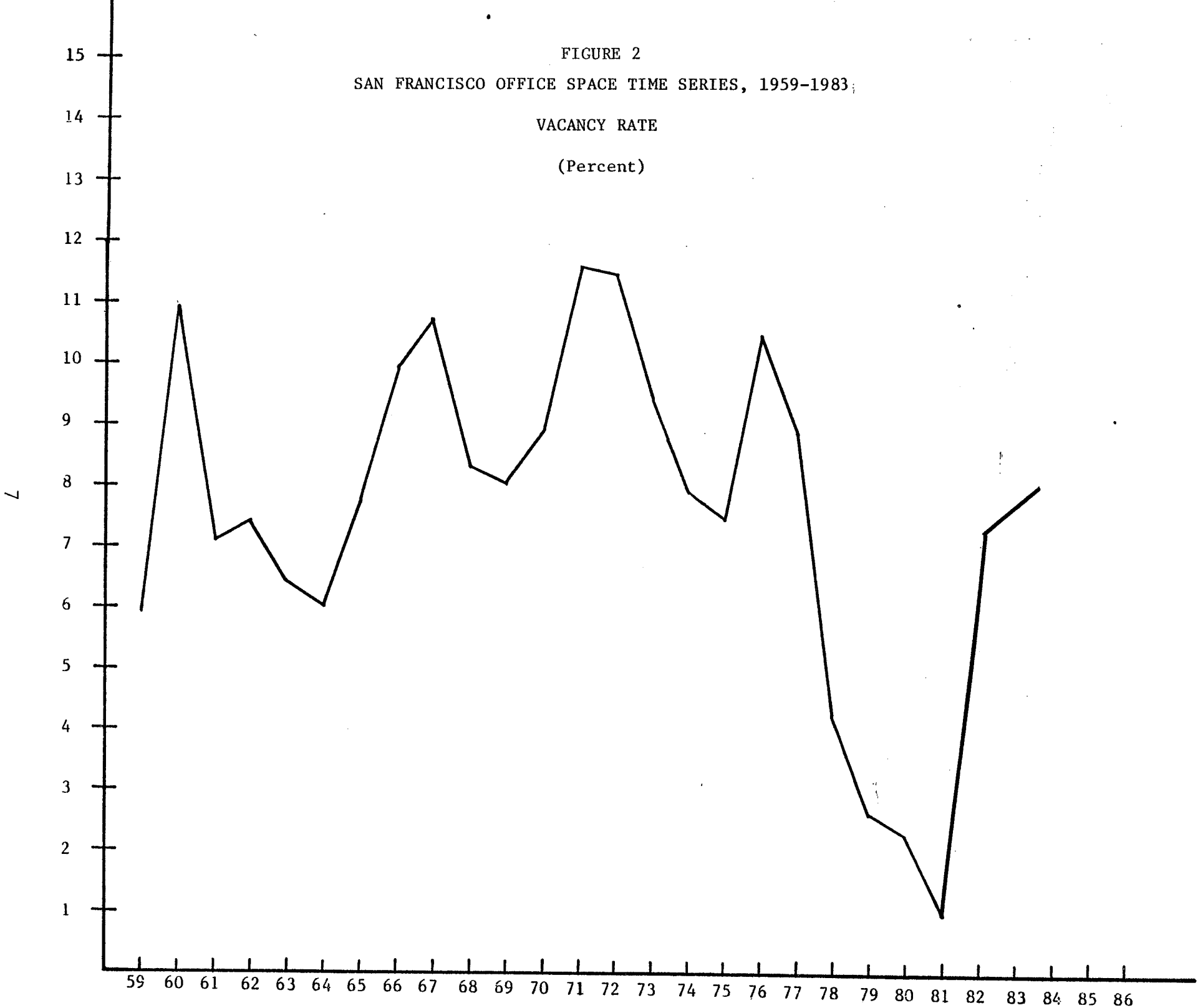
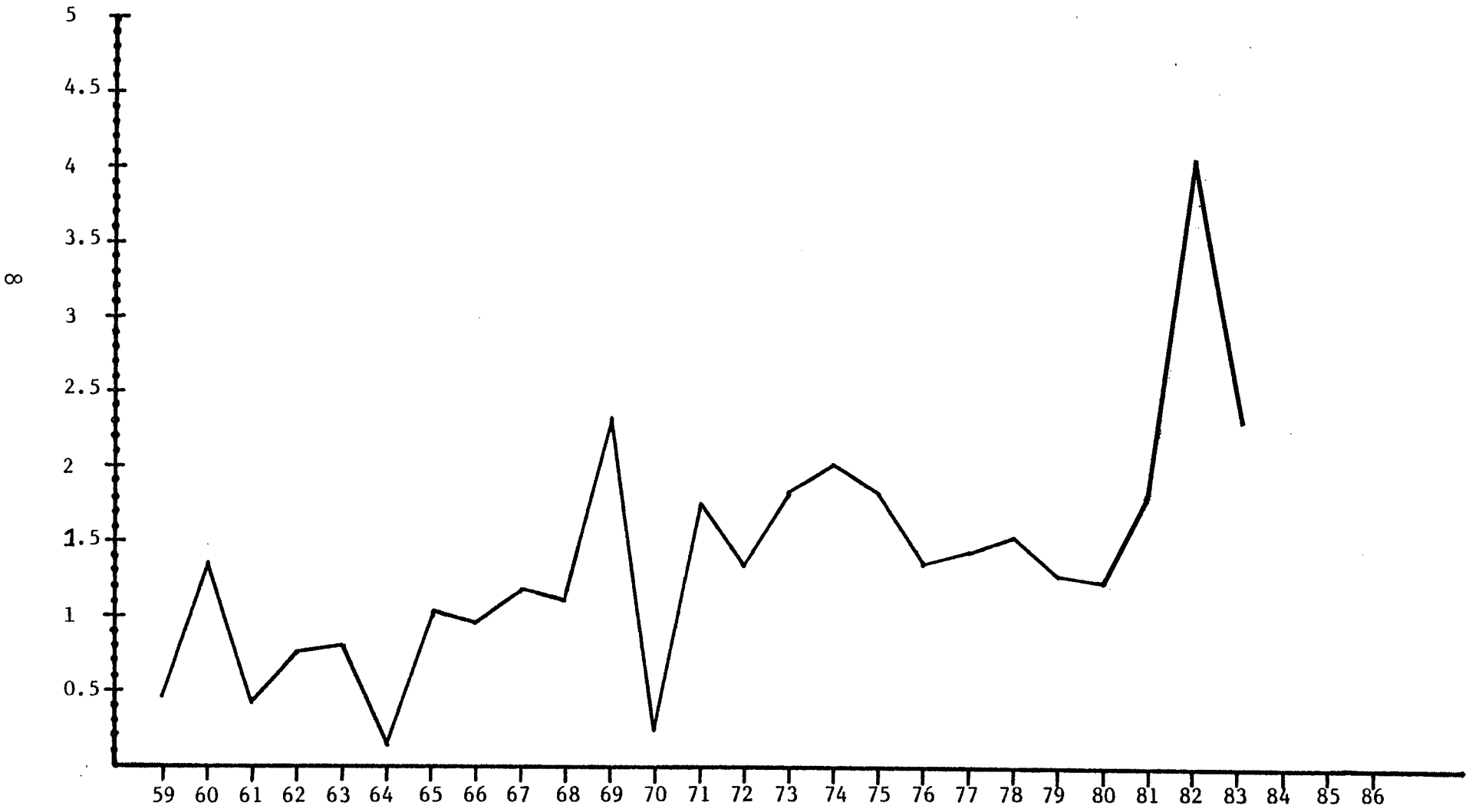


FIGURE 3

SAN FRANCISCO OFFICE SPACE TIME SERIES, 1959-1983

NEW CONSTRUCTION

(Millions Square Feet)



The estimated rent adjustment equation also confirms the theoretical formulation set out in equation (3). Changes in office rents are inversely related to the deviation of actual vacancies from optimal vacancy rates and are directly related to changes in the overall cost of living. The estimated equation shown below explains 55 percent of the first difference in office building rents.

$$(3E)\quad \dot{R} = \underset{}{-1.53} \underset{(.39)}{-} \underset{(2.72)}{2.09}\ (\dot{V} - 7\%) + \underset{(3.08)}{1.82} * \dot{p}\ (-1)$$

$$\bar{R}^2 = .55 \quad 1961 - 1983$$

The final equation estimated was a new construction equation. Equation (6) was implemented in a simplified form. Only a four year distributed lag on vacancy rates was significant in explaining new office building construction. As Figure 3 and the equation below shows, new construction is highly volatile and difficult to fully explain in an equilibrium econometric model. The vacancy rate is the only reasonable proxy for disequilibrium in the market and it is statistically significant.

$$(6E)\quad \Delta \text{Sq. Ft.} = \underset{}{3.53} - \underset{(3.48)}{.247} \underset{i=0}{\overset{4}{\Sigma}} \dot{V}(i)$$
$$\qquad\qquad\qquad\qquad\qquad\qquad (2.1)$$

$$\bar{R}^2 = .19 \quad 1966 - 1983$$

Summary

The office building model set out in Section II and partially estimated in Section III is the first attempt to develop a

detailed econometric model of the office building sector. Clearly, substantially more research needs to be undertaken before a full scale forecasting model of the office building sector is available.

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