Evaluation in Practice

A Methodological Approach

SECOND EDITION

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CHAPTER 12

The Simple Time-Series Design

The second type of reflexive design that we discuss is the time-series design. Although this design is a significant improvement over the one-group pretest-posttest design, it is still in the reflexive category, although some, such as David Nachmias, consider the time- series design to be quasi-experimental (Nachmias 1979, 57). This design is often referred to as a single interrupted time-series design, as the implementation of the program acts to interrupt the prevailing time-series. The impact of the interruption is interpreted as programmatic impact. The simple time-series design is shown in table 12.1.

Time-series designs are useful when preprogram and postprogram measures are available on a number of occasions before and after the implementation of a program. The design thus compares actual postprogram data with projections drawn from the preprogram period.

TABLE 12.1
The Simple Time-Series Design

	Before		After
Group E	$O_1O_2O_3$	X	$O_4O_5O_6$

The design is useful when adequate historical data are available (e.g., numerous data points) and when there appears to be an underlying trend in the data—that is, the data are fairly stable and not subject to wild fluctuations. Crime or accident statistics are good examples of data that are adaptable to the use of the time-series design. Finally, a simple time-series design is considered appropriate when no other rival explanations of the effect can be entertained. In the following article, "A Little Pregnant: The Impact of Rent Control in San Francisco," Edward Goetz uses the simple, interrupted time-series design to estimate whether the introduction of rent control had an impact on the construction of multifamily residences and the subsequent rents as advertised in local newspapers.

Supplementary Readings

Judd, Charles M., and David A. Kenny. 1981. *Estimating the Effects of Social Interventions.* Cambridge, England: Cambridge University Press, chap. 7.

Mohr, Lawrence B. 1988. *Impact Analysis for Program Evaluation.* Chicago: Dorsey, chap. 9.

READING

A Little Pregnant

The Impact of Rent Control in San Francisco

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The author uses an interrupted time series analysis to evaluate the housing market effects of moderate rent control in San Francisco. Using data on multifamily-housing construction and rent levels from 1960 to 1991, the analysis shows that rent control did not inhibit the development of new multifamily housing. In fact, the rate of multifamily-housing production has increased more rapidly after the program's initiation. Additionally, the analysis shows that rents for advertised units in San Francisco have significantly risen after the implementation of rent control.

AUTHOR'S NOTE: *I would like to thank Roger Herrera of the San Francisco City Planning Department and Mara Sidney of the University of Minnesota for their assistance in the collection of the data.*

RENT CONTROL IS an issue about which landlords, tenants, developers, and policy analysts are often passionate. It has been compared to a nuclear blast in slow motion by one economist (cited in Gilderbloom and Applebaum 1987). Another wrote, "next to bombing, rent control seems in many cases to be the most effective technique so far known for destroying cities" (Lindbeck 1972, 9). Yet, rent control remains popular with tenants' groups and low-income-housing advocates as a means of preserving affordable housing, averting rent gouging, and mediating runaway inflation in housing.

The claims made against rent control are many (see Gilderbloom 1981 for a list). Among the alleged negative effects are depression in the construction of multifamily-housing units (Phillips 1974; Sternlieb 1974; Lett 1976), decline in the maintenance of the housing stock (Kain 1975; Kiefer 1980; Lowry 1970; Rydenfelt 1972; Moorhouse 1972), greater levels of abandonment and demolition (Salins 1980; Lowry, DeSalvo, and Woodfill 1971; Phillips 1974; Sternlieb 1974), stagnation or decline in the local property tax base (Laverty 1976; Sternlieb 1974), and more recently (and more apocalyptically), homelessness (Tucker 1990). At the same time, a growing number of analyses show none of these adverse impacts (see, e.g., Gilderbloom 1981; Bartelt and Lawson 1982; Applebaum et al. 1991).

In this research note, I will use San Francisco as a case example to look at two issues: (1) whether rent control depressed the multifamily home-building market and (2) whether rent control had an impact on advertised rent levels. I use a time series statistical approach to analyze the empirical connection between rent control and these market effects.

Moderate Rent Control and Market Effects

San Francisco adopted rent control in 1979. An extremely heated housing market, low vacancy rates, highly publicized rent increases by large landlords, and a mounting campaign on the part of tenant groups to enact tough rent

control through the initiative process combined to persuade the board of supervisors to adopt their own, less strict form of rent control in June 1979 (see Hartman 1984, 236–45). The program has been in place continuously since then, with only minor modifications in the method of determining allowable rent increases. The program in San Francisco applies to all housing units, including single-family homes and condominiums, except those in buildings with four units or less in which the owner has lived for more than six months, units exempted through a special appeals process, and units constructed after June 1979, when the program was initiated.

The exemption for new construction, along with *vacancy decontrol,* which allows owners to raise rents to market level when apartments become vacant, makes the San Francisco program an example of *moderate rent control* (Gilderbloom 1981). Because of the special treatment of newly constructed units and vacated units, such programs can be expected to have little negative impact on the development of multifamily units and no dampening effect on rents for advertised units. On the other hand, Sternlieb (1981, 145) argued that "the term 'moderate rent control' is in the same dubious league as 'a little inflation' or 'a little pregnancy,'" suggesting that all rent-control programs will have uniformly negative effects on multifamily-housing construction. In the following analysis, I will use data from San Francisco to examine this issue.

Data

Data on the number of multifamily-housing units constructed in San Francisco were compiled from city records (Department of City Planning 1992).[1] Multifamily housing was defined as units in structures with two or more units. Although it is true that not all of these multifamily units are rental or that all single-family units are owner-occupied, construction figures broken down by tenure are not available. The correlation between housing structure and tenure is significant enough to justify the analysis. Figure 1 shows the pattern of multifamily home building in San Francisco from 1960 to 1992.

The figures for 1960 to 1966 are approximated. Figures from the city and county of San Francisco do not give the annual amount for these years, although totals broken down by building size are available for the entire seven-year period. The ratio of single- to multifamily units for the entire seven-year period was used to estimate multifamily-housing production on an annual basis. It was assumed that the ratio of single- to multifamily housing for the seven-year period was matched for each individual year.

The vertical line in the graph marks the adoption of rent control in San Francisco in 1979. My hypothesis is that rent control will have no negative effect on the rate of multifamily-housing construction. The data seem to indicate this is the case. There was a significant drop in production during the late 1960s, a slight recovery during the mid-1970s, another trough through the late 1970s and early 1980s, and a final rebound from 1984 to 1992. The decade of the 1970s saw a heavy migration into the city that put extreme pressure on the local housing market (Hartman 1984). The city also experienced huge levels of downtown commercial development between 1970 and 1985 that attracted new residents (DeLeon 1992). Housing production did not keep pace with population growth during the 1970s, and after the construction market bottomed out completely during the recession of 1981–1982, there was enormous built-up pressure for housing production.

Data on rents in San Francisco were collected for each year from 1960 to 1991. Listings of two-bedroom apartments in the *San Francisco Chronicle* were surveyed, using the

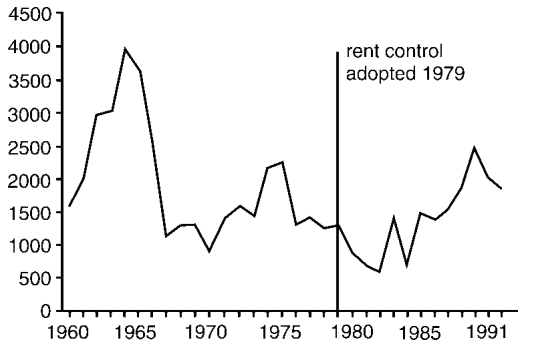

FIGURE 1
Multifamily Housing Units Constructed in San Francisco, 1960–1991

first Sunday in March for each year. Median rents for each year were computed and then adjusted for inflation. It is important to note that these rent figures are for apartments that are vacant. They do not reflect rents paid by tenants remaining in their units. In the analysis, I use the inflation-adjusted median-rent figures. Figure 2 shows the pattern of change for the median rent in San Francisco during this period.

Figure 2 shows a steady increase in rents, even when adjusting for the effects of inflation. The graph seems to indicate a higher upward slope in rents after adoption of rent control in 1979.

Analysis

Multifamily-Unit Construction

Time-series equations were estimated to determine the impact of rent control on multifamily-housing construction and rent levels in San Francisco. The initial equation estimated for each dependent variable was

$$Y_t = b_0 + b_1X_{1t} + b_2X_{2t} + b_3X_{3t} + e_t,$$

where Y_t = number of time-series observations of the dependent variable (either multifamily-housing unit completions [$N = 32$] or median rent [$N = 31$]); X_{1t} = a time counter from 1 to 31; X_{2t} = a dummy variable coded 0 for those years before adoption of rent control and 1 for years following adoption; X_{3t} = a dummy variable scored 0 for years before adoption of rent control and 1, 2, 3 … for years after adoption of the program; and e_t = the error term.

In this simple interrupted time series model, X_1 can be interpreted as the slope or trend in the dependent variable prior to the intervention, X_2 is a measure of the change in the intercept or level of the dependent variable attributable to the intervention, and X_3 is the change in the slope or trend of the dependent variable that was due to the intervention (Lewis-Beck 1986).

Equation 1 is

$$MFU_t = 2751.9 - 80.49X_{1t} - 670.3X_{2t} + 194.9X_{3t} + e_t$$
$$(8.7^*)\ (-2.9^*)\ (-1.4)\ (3.4^*)$$
$$R^2 = .42\ N = 32\ \text{D–W} = .86$$

where MFU_t indicates annual multifamily-housing-unit construction levels for the years 1960 to 1991; the figures in parentheses indicate t-ratios; * indicates t-ratio significant at the $p < .05$ level; D–W is the Durbin Watson statistic.

The data show a statistically significant downward trend in multifamily-housing construction of 80 units per year in San Francisco prior to the adoption of rent control ($-80.49X_{1t}$). The coefficient for the change in in-

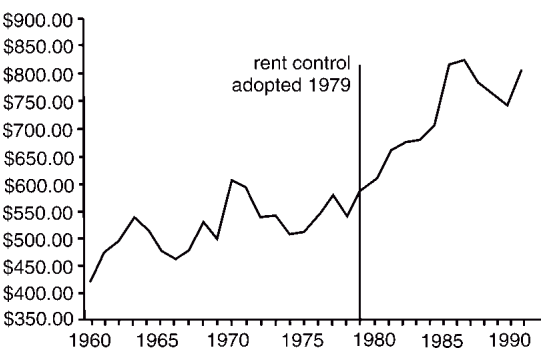

FIGURE 2
Median Rents, San Francisco, 1960–1990

tercept (670.3) is statistically insignificant. Finally, the coefficient for X_{3t} (194.9) indicates a statistically significant change in the trend of multifamily-housing completions in San Francisco. The post-rent-control period saw a greater upward trend in production than did the period before adoption of the program. This effect is clearly related to the relatively high levels of production in the city during the early 1960s. Yet, the data conclusively show that moderate rent control did not suppress multifamily-housing production.[2]

Equation 1 was rerun with two additional variables. The number of housing units completed in the entire western region of the United States was included as a measure of the strength of the construction industry. This measure was statistically insignificant in the equation and significantly reduced the efficiency of the overall equation, so it was dropped. The same results were produced when the average prime lending rate for each year was added to the equation to account for the state of the lending market. Given the lack of explanatory power of these variables, the simple interrupted time series was used.

Sternlieb (1981) suggested that the production effects of rent control are likely to be lagged a number of years, taking into account the long pipeline for most housing developments. Equation 1 was rerun with variables X_2 and X_3 lagged up to three years. No change in the results occurred.

The Durbin-Watson statistic indicates a problem with autocorrelation. Adjustments to the data were made to remove the autocorrelation of the error terms (Lewis-Beck 1986) and the equation was rerun.[3] The adjusted equation confirms the earlier results.

Equation 2 is

$$MFU_t = 1584.5 - 140.3X_{1t} - 208.7X_{2t} + 245.0X_{3t} + e_t$$
$$(5.2^*)\ (-2.7^*)\ (-.37)\ (2.5^*)$$
$$R^2 = .26\ N = 31$$

The downward trend in production prior to rent control remains significant (a decline of 140 units per year). The reduction in the mean number of units produced after the program was initiated (208.7) is statistically insignificant. Finally, the change in the trend in production is positive and statistically significant, the coefficient showing an increase in the rate of construction of 245 units after rent control was initiated. These findings demonstrate quite clearly that moderate rent control did not have a negative effect on the production of multifamily units in San Francisco.

Rent Levels

Equation 3 is

$$MDR_t = 470.7 + 4.76X_{1t} - 35.7X_{2t} + 13.94X_{3t} + e_t$$
$$(24.3^*)\ (2.80^*)\ (1.16)\ (3.7^*)$$
$$R^2 = .89\ N = 31\ D\text{–}W = 1.12$$

where MDR_t indicates the median advertised rent for two-bedroom apartments as listed on the first Sunday in March for the years 1960 to 1991; the figures in parentheses indicate t-ratios; * indicates t-ratio significant at the $p < .05$ level; and D–W is the Durbin Watson statistic.

This equation indicates a steady and significant upward trend in rents during the pre-rent-control period (4.76_{1t}), followed by a significantly accelerated rate of increase after adoption of rent control. The coefficient for X_{2t} is statistically insignificant, suggesting virtually no change in the intercept at the intervention point.

The Durbin-Watson statistic indicates trouble with autocorrelation, however. The model was rerun in the manner previously described. The resulting equation is similar to Equation 3 in all respects except that the coefficient for X_{1t} falls below the level for statistical significance. The data nevertheless suggest that there has been a significant change in the rate of rent increases ($15.82X_{3t}$, $p < .05$) since the adoption of moderate rent control in San Francisco.

Equation 4 is

$$MDR_t = 288.2 + 3.03X_{1t} + 40.6X_{2t} + 15.82X_{3t} + e_t$$
$$(14.3^*)\ (1.09)\ (1.11)\ (2.90^*)$$
$$R^2 = .77\ N = 30$$

A Little Pregnant in San Francisco

The findings suggest that it is, indeed, possible to be a little pregnant with rent control. That is, the particular form that rent-control programs take can have consequence for market outcomes. The evidence indicates that moderate rent control in San Francisco did not have an inhibiting effect on the production of multifamily units in the city as critics of rent control would predict. Vacancy decontrol has produced its own market effect as well. The data presented here indicate that rent levels for advertised units increased over the entire period from 1960 to 1991, even when adjusting for inflation. Furthermore, the increase in rent levels was significantly greater after adoption of the rent ordinance. The moderate form of rent control operated in San Francisco, therefore, does not protect a newcomer to the housing market or protect those who choose, or are forced by any circumstance, to move. For rent-control advocates, this clearly mitigates the positive impact the program presumably has on maintaining lower rents in occupied units. The vacancy-decontrol clause in the San Francisco program has clearly provided landlords and management companies the opportunity to inflate rents on unoccupied units. Rent-control advocates and opponents of vacancy decontrol suggest that these circumstances lead to an incentive for landlords to evict long-term residents to bring rents up to market levels. Though this analysis provides no data on this question, it does suggest the logic is sound.

Notes

1. This document contained figures dating to 1982. Previous figures were obtained from earlier such documents. Figures back to 1960 were obtained from Roger Herrera, planner, city of San Francisco.
2. The very high levels of multifamily-housing production in the early 1960s are important to the regression findings. These years are the estimated figures described earlier. Multifamily-housing production for each year between 1960 and 1966 was set at 84% of the total housing production, matching the percentage for the entire seven-year period. In most years, multifamily-housing production was an even greater proportion of total production. In fact, multifamily housing as a percentage of all housing built in San Francisco has exceeded 84% in 8 of the 12 post-rent-control years. It is highly unlikely, therefore, that the method used to estimate annual multifamily-housing production from 1960 to 1966 resulted in overinflated figures.
3. The autocorrelation coefficient, p, was estimated for the equation and then each variable in the equation was adjusted by the following equation, $X = X_t - pX_{t-1}$ (Lewis-Beck 1986).

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Explanation and Critique

In this study Goetz uses the interrupted time-series design to estimate the impact of rent control in the case of San Francisco. Earlier studies had demonstrated mixed results, and Goetz was interested in determining whether the San Francisco model of rent control, "mild" (as in being a little pregnant) as opposed to "full blown" rent control, supported earlier findings or was a case unto itself. The "interruption" is the adoption of rent control as indicated in figures 1 and 2 of the article.

The first dependent variable examined is the number of multifamily units constructed each year for the 32 years between 1960 and 1991. The data for the number of multifamily units constructed between 1960 and 1966 are estimations that Goetz infers are conservative based on actual figures in the post–rent control period (see footnote 2 in article). The independent variables include two time counters, one that measures the passage of time throughout the 32 years from 0 to 31 and one that reflects the time subsequent to the adoption of rent control. The other independent variable, referred to as a "dummy" variable (chapter 3), takes on the value of "0" during the pre–rent control period and "1" for the post–rent control period.

On the basis of the time-series equations, Goetz concludes that the number of multi-

family units constructed went down even prior to the adoption of rent control (b = –0.49) and increased after rent control was in place. Although this finding is verified visually (see below), that is not the literal interpretation of the coefficient. As indicated in chapter 3, the coefficient is interpreted that as the value of X increases one unit, the value of Y changes in the direction of the sign by "b-units" of Y. Therefore, the number of units constructed goes down generally as time passes, even though it "appears" to increase after the adoption of rent control. Separate equations pooling the pre- and post-intervention years would demonstrate what we see visually. The postintervention effect is adequately demonstrated by the impact of the final count variable, which measures the postintervention impact. We do agree, though, that because the coefficient for the dummy variable indicating the change to rent control was insignificant, rent control itself had no impact. These findings remain consistent even when controlling for autocorrelation (equation 2 in article).

Let us assess these findings visually by looking at Goetz's figure 1. It is clear that there was a drop-off of constructed units after the high productivity of the 1990–1996 period. Coincidentally, this productive period was the one for which the number was estimated by Goetz. Although we do not have any problem with how he arrived at the estimates, we do have some concerns regarding how appropriate the application of a linear statistic is with data that do not exhibit a linear trend. Regression-based estimates are adversely affected by wide fluctuations as shown in the pre–rent control period. Oftentimes these fluctuations are "smoothed" out by using three-year moving averages, for example. The series for the post–rent control period does not exhibit such fluctuations and appears to be indicative of a trend.

The third and fourth equations estimate the impact of rent control on the median advertised rents for two-bedroom apartments. Recall that the effect of mild rent control is that newly constructed dwellings and new residents of heretofore rent-controlled units were not covered by the controls. Goetz finds that although rents were increasing before the institution of controls, the increases were significantly accelerated in the post–rent control period. This trend is clearly visible from figure 2 in the article. Moreover, since there are not extreme cases as in the first two equations, the interpretation of the coefficients is reasonable.

In the introduction to this chapter, we pointed out that the use of interrupted time-series designs is appropriate when no other rival explanations of the effect can be demonstrated. Here, Goetz acknowledges that other factors might be operating; however, it may be useful to point some of them out clearly. First, the decrease in the number of multifamily housing units in the pre–rent control era is dominated by the extreme cases of the period before 1966. If the time-series began in 1966, there actually appears to be an increase in the trend concomitant with the increased migration to San Francisco to which Goetz alludes. The decrease begins during a period of high inflation in the second half of the 1970s and bottoms out during the height of the recession of the early 1980s. These are rival hypotheses that seem to make sense.

In terms of the median rent increases during the post–rent control era, there are some items to be reconsidered. Recall that the rents that are not covered by the controls are those of new units and for new residents in previously rent-controlled dwellings. It makes sense that landlords would want to increase rents in tighter markets (which San Francisco was experiencing), and also to make up lost earnings due to rent control by raising the rents of new residents. What is not measured here is the overall impact on renters—both new and those under rent-control restrictions. Certainly, rent control had a

positive impact on those who continued to live in rent-controlled units. Therefore, there may be more of an impact than this evaluation suggests, albeit for only a subset of the renting population.

Once again, use of the single interrupted time-series design is justifiable in cases where no rival hypotheses could be entertained to produce the observed impact. The classic study in this regard was Robert Albritton's (1978) study of the impact of a permanent federal program to eradicate measles in the school-age population in 1966. Finding that the program had a substantial impact that continued over time, Albritton sought rival explanations for the impact. Because the number of school children had not declined and the impact remained even when statistically controlling for the private use of measles vaccine, he concluded that the impact of the program was real. Even though the federal program required improved measles reporting procedures, thus increasing reported incidence, the impact remained. Albritton pointed out that this attenuated his estimates of the impact. Therefore, in reality, the impact was even greater than that estimated. No rival hypothesis could possibly explain the impact. Therefore, when considering the results of this and any type of evaluation design, question whether any rival hypotheses could be introduced to falsify the findings.

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