Review of Income and Wealth
Series 35, Number 3, September 1989

THE MEASUREMENT OF HOUSING OUTPUT: U.S. AND SOVIET CASE STUDIES

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This paper examines the measurement of the output of the Housing industry in real GNP accounts of the U.S., the Soviet Union, and selected OECD countries. These real GNP accounts make use of quite different Housing indexes, based on different types of data. This paper's major empirical finding is that the (measured) growth rate of Housing output can be extremely sensitive to the type of index used.

After reviewing the concept of housing quality, the paper presents U.S. and Soviet case studies. The BEA and the CIA do not use identical procedures to measure Housing output for the U.S. and the Soviet Union: the BEA measures many more aspects of housing quality improvements than the CIA does. This difference in the two agencies' procedures increases the growth rate of the U.S. Real Estate industry relative to the growth rate of the Soviet Housing industry. The idea behind the two case studies is to remeasure Housing output for the Soviet Union (U.S.) using an index that approximates the BEA (CIA) index. The purpose of these studies is the calculation of numerical magnitudes: to what *degrees* are the levels and growth rates of Housing sensitive to the type of index that is used. The calculations for the U.S. are useful because they show the important role of housing quality growth in the U.S., and because they make the magnitudes reported for the Soviet Union more credible. The Soviet case study provides numerical support for the proposition that the post-WWII growth rate of Soviet housing quality has been considerable and exceeds the growth rate implicit in the CIA output figures.

I. INTRODUCTION

This paper examines the measurement of the output of the housing industry in real GNP accounts (by industry of origin) for the U.S., the Soviet Union, and selected OECD countries. The industry's output—the "flow of housing services"—is difficult to measure in constant prices. The real GNP accounts of various countries make use of different housing indexes, based on different types of data. In this paper the major empirical finding is that the (measured) growth rate of housing output can be *extremely* sensitive to the specific type of index used for national accounts. This result is demonstrated in two case studies, one for the United States and one for the Soviet Union. The interesting feature of these studies is that they derive numerical *magnitudes* (for each country) of the effect of substituting one type of housing index for another.

Although the case studies were conducted for the U.S. and the Soviet Union, the results of these studies are applicable to all countries because the underlying

Note: The research for this paper was conducted as part of my doctoral dissertation. I am grateful to my thesis supervisor, Martin Weitzman, for his valuable comments and recommendations. Evsey Domar provided helpful suggestions as well. James Noren and Gertrude Schroeder provided both data and encouragement. I would also like to thank two anonymous referees for their editorial suggestions, which improved the organization and clarity of the paper. Any errors are of course the responsibility of the author.

index problems are the same. Furthermore, the sensitivity of housing output to the procedures used for measurement should be a concern not only to specialists on housing, but also to many others who use national accounts. Since the base year output of housing is typically a sizeable share of GNP and an even larger share of service sector output, a given change in the measured growth rate of housing (due to substituting an alternative type of housing index) may have a discernable effect on output at the national level and, *a fortiori*, the level of the service sector.

The Office of Soviet Analysis of the U.S. Central Intelligence Agency (CIA) carefully estimates real Soviet GNP using as a model the real U.S. GNP accounts of the U.S. Bureau of Economic Analysis (BEA). Since the accounts are based on Western methodology, the CIA's Soviet accounts are often used in the West for comparisons between the Soviet economy and the economies of other countries. Among the housing indexes reviewed here is the one used by the CIA for its Soviet accounts. The official Soviet measure of housing output can not be examined because it does not exist; the Soviet Union's official measure of its "national output" (called Net Material Product) does not include the output of housing and most other service industries.

The BEA and the CIA do not use identical procedures to measure U.S. and Soviet GNP: what is important is whether the differences in procedures create biases which *systematically* affect results. In the case of the housing industry, there is a strong bias—and it systematically increases the growth rate of the U.S. real estate industry (SIC 65/66) relative to the growth rate of the Soviet housing industry.[1]

The source of the bias is simple. The BEA and the CIA both measure the growth rate of the *quantity* of housing for, respectively, the U.S. and the Soviet Union. The U.S. accounts also record many aspects of housing *quality* improvements. In contrast, the CIA figures are based on an index of total housing area in the Soviet Union. An area index reflects changes in only one aspect of housing quality—increases in area per housing unit. The difference between the two agencies' treatment of housing quality generates a *relative* bias that raises the U.S. growth rate relative to the Soviet growth rate for the housing industry. This relative bias in turn enhances the GNP growth rate of the U.S. relative to the Soviet Union.

The term "bias" unfortunately has negative connotations which may suggest that "incorrect" procedures have been used. The CIA makes an earnest and scholarly effort to estimate Soviet GNP, and those biases which remain in the Soviet accounts are due in large part to a lack of detailed Soviet data. In this paper, the term "bias" has a statistical meaning which merits further attention.

The bias between the U.S. and Soviet housing output is a *relative* bias. The growth rate of the Soviet housing industry would *increase* if available Soviet data permitted the CIA to replicate the BEA's procedures for its Soviet accounts.

[1]The industry which this paper calls "U.S. real estate" and treats as comparable to the Soviet housing industry is composed of two separate two-digit industries, SIC 65 and SIC 66, under the U.S. Standard Industrial Classification System. The combination of the outputs of these two industries does create problems which are discussed below.

Alternatively, the growth rate of U.S. real estate output would *fall* if the CIA procedures were used for the U.S. accounts. (Each of the case studies attempts to make one of these two "adjustments.") What is statistically important is simply that the BEA and the CIA use different procedures. Semantically, either set of accounts could be adopted as the "standard," and the other set would be "biased" *relative* to that standard. It is sensible to consider the CIA accounts to be biased relative to the BEA accounts because (a) the BEA's data and procedures are more detailed than the CIA's, and (b) the CIA has adopted the BEA accounts as a model.

An overview of the paper is the following. In Section II the author explains the concept of housing quality used by this paper, and the extent to which the housing indexes of the U.S., the Soviet Union, and selected OECD countries reflect quality growth.

Section III contains a brief U.S. case study. An index of the number of U.S. housing units is used to estimate "adjusted" output ("adjusted" to *omit* all quality growth) for the U.S. real estate industry. Once the meaning and measurement of housing quality is understood, it becomes obvious that the measured growth rate of U.S. housing output falls when a quantity-only index is substituted for the BEA index. Perhaps then the qualitative results of this section are not surprising; the *direction* of changes is predictable. The purpose of the section is the calculation of numerical magnitudes: to what *degrees* are the levels and growth rates of housing sensitive to the type of index that is used. This calculation is useful because it shows the important role of housing quality growth in the U.S., and because it makes the magnitudes reported for the Soviet Union in Section IV more credible.

The Soviet case study presented in Section IV is the main motivation for the paper. The section first provides evidence, mainly drawn from descriptions of Soviet housing, that the *growth rate* of Soviet housing quality has been substantial. The culmination of the paper is the proposal that an index of capital invested in Soviet housing would be an excellent proxy for the kind of index used by the BEA to measure U.S. real estate. This theoretical proposition is supported by showing that the growth rates of capital and output are similar in U.S. real estate. In the Soviet case study an index of Soviet housing capital is used to estimate "adjusted" output ("adjusted" to *include* housing quality growth—unlike the "adjustment" made in the U.S. case study).

A major qualitative result of Section IV is that the growth rate of "adjusted" Soviet housing output exceeds the growth rate of the CIA figures. Perhaps this result is at first surprising because there are numerous anecdotes that, relative to some OECD countries, the level of Soviet housing quality is "low." A careful distinction must be maintained here between the *growth rate* and the *level* of housing quality. This paper neither supports nor refutes the widespread belief that the level of Soviet housing quality is currently poor by Western standards. Instead it is argued that the post-WWII growth rate of Soviet housing quality has been considerable (perhaps because the level of quality was very "low" in 1950), and exceeds the growth rate implicit in the CIA output figures.

The paper concludes with Section V in which the major findings are summarized.

II. The Meaning and Measurement of Housing Quality

Usher describes three models of quality change (one of which is a special case of another). He concludes that "none of these models captures the whole of what we think of as quality change" (13, p. 153). One model however is well-suited for comparing the procedures of various national statistical agencies. This model is based on the concept of "characteristics."

One useful view of a "characteristic" is that it is any feature of a good which is valued by the consumer. Housing characteristics would include such features as floor space and the number of bathrooms. One perspective of GNP (the "welfare" interpretation) states that real GNP growth occurs when the representative consumer, facing a choice between "yesterday's" and "today's" prices and incomes, prefers "today's" conditions. Since it is the characteristics of housing—not merely the number of housing units—that enters the representative utility function, real GNP measurement should reflect improvements in housing quality. If a direct measure of the value consumers attach to a characteristic is unavailable, it may be approximated by the production cost of the characteristic.[2]

The term "quality adjustment" is used in two different ways in economics. The literature on hedonic pricing has developed regression techniques for identifying that part of a change in a *single* commodity's price that is due to a change in the levels of its characteristics. A second use for the term "quality adjustment" can be found in the productivity literature in which a heterogeneous commodity such as "labor" is divided into multiple categories. This paper uses the term "quality adjustment" primarily in the same sense that productivity studies do.

Quality adjustment begins by distinguishing a variety of types, categories, or grades of a commodity according to the commodity's characteristics. The price of each category is used as a weight on the annual quantities of that category to obtain a "quality-adjusted" index of the commodity. An example of quality adjustment from productivity studies is the use of a weighted index of labor, in which various categories of labor are weighted by their corresponding wage rates. In contrast, a "simple" unweighted labor index aggregates the annual volume of manhours or employment by (unweighted) summation. Weighted indexes are appropriate when the annual quantities of various categories grow at different rates.[3] Quality adjustment through the use of weighted indexes is theoretically sound and in practice can be large in magnitude.

A feature of many economies is that growing percentages of the housing stock consist of relatively high-quality units. A weighted index of housing (or any commodity) is "limited" in that it does not detect *all* of the improvements in quality. The use of such an index implicitly assumes that the levels of characteristics *within* each category are constant over time, i.e. that the only source of

[2]An alternative perspective on "quality" considers any feature of a good that *requires resources* to be a "characteristic" (11, p. 294). Under this view, production cost is a direct measure of "quality" because it measures the resources absorbed by a characteristic. Either interpretation of "quality" may be adopted for the purposes of this paper.

[3]If all categories grow at the same rate, i.e. if there are no changes in the proportions of different categories, then quality adjustment is trivial because in this case weighted and unweighted indexes grow at the same rate.

growth in national totals of characteristics is due to inter-category shifts in the composition of the housing stock.

A rent index identifies as many distinct housing categories as there are quantity "weights" in the index. Measuring housing output in constant prices by deflating current-price rental payments is similar to using a weighted index of the quantity of housing to extrapolate base year output.[4] So when real output is measured using deflation, the figures automatically reflect quality adjustment to some degree.

In the remainder of this section, the author briefly summarizes the procedures used to measure housing output in the U.S., the Soviet Union, and various OECD countries.

The 1950–1984 output figures used in this paper for the U.S. real estate industry were obtained directly from the Bureau of Economic Analysis. The real estate figures represent the combined output of the two-digit industries Real Estate (SIC 65), and Combinations of Real Estate, Insurance, Loans, and Law Offices (SIC 66). This aggregation occurs because the BEA reports output figures for these two industries in combination. In a review of official measurement procedures it was reported, "There are no separate calculations for the combination offices (SIC 65) since they are relatively small and should have little effect on the group (SIC 65/66) total" (7, p. 32).

It is unfortunate for this paper that the BEA combines SIC 65 and SIC 66 when it measures real output. The comparison between the "adjusted" and BEA real estate figures in Section III is not purely a comparison between two measures of housing output—one of which includes quality growth and the other of which omits it; other types of output are mixed into the SIC 65/66 figures.[5] Therefore, the results of the section are not absolutely conclusive. However, the above explanation for not deflating SIC 66 separately is that the output of that industry "should have little effect on the group total." So although inaccuracies are present, it is hoped that they have only minor effects on the basic results of the paper. The calculated orders of magnitude in Section III are at least indicative of the important role of housing quality growth.

The real estate industry SIC 65/66 includes a variety of activities. Three price indexes are used in the construction of an implicit price deflator (IPD), one of which is the rent index component of the Consumer Price Index (CPI), (7, p. 32). However, it will be assumed that the entire output of SIC 65/66 consists of the flow of housing services, and that the rent index component of the CPI is used to deflate current-price output for the entire industry.

The Bureau of Labor Statistics (BLS) devotes considerable effort to the construction of monthly rent indexes for the CPI, the annual averages of which are used by the BEA to obtain the annual constant-price figures. As of 1984, the

[4]For a given set of data containing annual observations on both prices and quantities, extrapolation of a base year value by a Laspeyres quantity index is numerically equivalent to deflating current-price values by a Paasche price index. In actual practice, the choice of using extrapolation or deflation does matter for "statistical" reasons involving the ease and accuracy of obtaining quantity or price data on an annual basis. For the purposes of this paper, though, the real output figures that result from extrapolation and deflation can be thought of as equivalent.

[5]I would like to thank an anonymous referee for suggesting that this point should be emphasized.

BLS was using a group of about 23,000 specific rental units in an on-going rent survey. The BLS reports:

> In order to collect the monthly information necessary to calculate the rent index, the sample is divided into six panels of approximately 3,800 units each. The units in each panel are visited by BLS field staff twice a year on a 6-month cycle. The information collected includes the rents paid for the current month and the previous month, information on extra charges and reductions, a description of the unit, and the facilities included in the rent. The latter questions are used to make quality adjustments to the calculated rents . . . . For instance, if the owner no longer provides a certain utility, BLS would calculate and add an estimate of the value of that utility to the current rent in order to have an adjusted rent value (25, pp. 15, 18).

Beginning in January, 1988, the BLS began to make an adjustment for the age of a rental unit using hedonic methods (24, p. 4). The use of hedonic techniques in addition to the construction of a rent index with thousands of units in the sample results in a high degree of quality adjustment.

Many countries besides the U.S. use deflation when measuring housing output, and therefore housing output for these countries also reflects quality adjustment. These countries include most OECD countries, e.g. France, Great Britain, West Germany, Canada, Norway, Sweden (3, pp. 50–51), and Australia (1, p. 109).

Two countries in which national accounts record little or no housing quality improvements are the Netherlands and Italy (12). In the Netherlands, an extrapolation index is developed using only the number of housing units. The extrapolation index in Italy is the number of rooms. Italy's index measures not only the growth of the number of units but also reflects increases in the number of rooms per unit, which is one type of quality change.

The CIA's Housing Area Index for the Soviet Union is the total area of "living space" for state-owned and private housing (20, p. 343). In comparison with those OECD countries for which many types of quality growth are recorded (such as the U.S.), the growth of Soviet housing output is systematically underestimated. (The growth of Dutch and Italian housing output is also systematically underestimated relative to many other OECD countries.)

Of course, omitting quality growth is a problem for national accounts only to the extent that quality per housing unit grows. In particular, the CIA's use of a total area index is biased only to the extent that quality per square meter has increased. In order to investigate the magnitudes of these sorts of effects, the following two case studies were conducted.

III. The U.S. Case Study

In this section the author calculates what the levels and growth rates of U.S. real estate output would be if quality growth were not measured. These annual "adjusted" figures are estimated by extrapolating (1982) base year output using an index of the annual number of U.S. housing units. The section begins with a

description of the data from which the index was constructed. Then "adjusted" levels and growth rates are calculated and compared to the levels and growth rates of the BEA figures. Finally, the author proposes that the index of U.S. housing units is a reasonable proxy for a CIA-like index of total U.S. housing area.

The index of the number of U.S. housing units was based on the following censuses and surveys: April, 1950 (14, p. XXV); December, 1956 (18, p. 13); April, 1960 (14, p. XXV); April, 1970 (21, Part A, 1974, p. XV); October 1973-81, and October, 1983 (21, Table A). Each census figure was interpreted as a measure of the number of units as of the January nearest to the month of the census. Therefore census figures were available for 1950, 1984, and various intermediary years. A stock-flow equation—based on units, newly-constructed units, and net units demolished—was used to estimate annual stocks for inter-census years.

The BEA currently uses 1982 as the base year for the U.S. real GNP accounts by industry of origin. In this paper the author takes the BEA's real estate figures for 1982 as given. The only difference between BEA figures and this paper's "adjusted" figures is that different indexes are used to estimate output for other years. The annual figures of the number of units were divided by the (1982) base year number of units (91,561 thousand) to obtain the units index. The units index extrapolated base year output of U.S. real estate (342,728 million dollars) to obtain annual "adjusted" output for 1950-1984.

In Table 1 the BEA figures for output, the "adjusted" figures, their differences and their relative differences (as percentages of "adjusted" output) by five-year intervals (except for the 1980-1984 period) are shown.

By construction, the differences and relative differences are zero for 1982. The growth rate of BEA figures usually exceeds the growth rate of "adjusted" figures, and therefore the BEA figures will tend to be above (below) the "adjusted" figures in years that follow (precede) the base year. The annual differences and relative differences tend to increase (in absolute value) for years that are more distant from the 1982 base year.[6]

TABLE 1

U.S. REAL ESTATE OUTPUT

(Millions dollars)

Year	(1) BEA Figures	(2) "Adjusted" Figures	(3) Difference (2)-(1)	(4) Relative Difference (3)/(2)
1950	82,209	172,698	−90,489	−52%
1955	111,032	197,747	−86,715	−44%
1960	147,357	218,855	−71,498	−33%
1965	190,642	241,311	−50,669	−21%
1970	232,216	262,710	−30,494	−12%
1975	283,431	290,473	−7,042	−2%
1980	339,567	323,312	16,255	5%
1984	364,989	350,057	14,932	4%

[6]There is an exception to this pattern for the five years prior to 1982 during which BEA figures exceeded "adjusted" figures (by an average of 5 percent of the "adjusted" figures).

Table 1 is important because it provides estimates of the *magnitude* of the effects of using different housing indexes. The 1984 BEA output figure exceeds "adjusted" output by $14,932 million, or by 4 percent of "adjusted" output. This effect is relatively small because 1984 is so close to the base year. A comparison of BEA and "adjusted" figures for 1960 or 1950 is much more impressive because these two years are twenty to thirty years from the base year. In 1960, BEA output is below "adjusted" output by $71,498 million or by one-third of "adjusted" output, while 1950 figures differ (in absolute value) by 52 percent.

It is demonstrated in Table 1 that different housing indexes can generate considerable differences in output levels over some period of time. Of course, the inclusion or omission of quality growth in the index will make little difference in a short period; the nature of compounded growth requires that several years pass for the effects to become evident.

The growth rates for BEA and "adjusted" output, as well as the differences in growth rates and the relative differences (as percentages of "adjusted" growth rates) are shown in Table 2.[7]

The differences between BEA and "adjusted" growth rates are nearly always positive. Economic theory predicts that positive relationship, so long as quality improvements occur; the qualitative results of Table 2 are not remarkable. The table is important because it shows the magnitudes of the differences. For the postwar period as a whole (1951-1984), the BEA figures grow at 4.48 percent while the "adjusted" figures grow at 2.10 percent. The 2.38 percentage point difference is a very large 113 percent of the "adjusted" growth rate. So when quality growth is included in the U.S. housing index, the growth rate of output *doubles.* This result is a long-term result; for some periods the growth rates does not double while for other periods it more than doubles. These figures support the claim made in Section I that the growth rate of housing output is extremely sensitive to the type of index used to measure output.

TABLE 2

GROWTH RATES OF U.S. REAL ESTATE OUTPUT

(Average annual)

Period	(1) BEA Figures	(2) "Adjusted" Figures	(3) Difference (2)-(1)	(4) Relative Difference (3)/(2)
1951-55	6.20	2.75	3.45	125%
1956-60	5.82	2.05	3.77	184%
1961-65	5.29	1.97	3.32	169%
1966-70	4.02	1.71	2.31	135%
1971-75	4.07	2.03	2.04	100%
1976-80	3.68	2.17	1.51	70%
1981-84	1.82	2.01	−0.19	−9%
1951-84	4.48	2.10	2.38	113%

[7]Unless explicitly stated otherwise, all growth rates in this paper are computed using the average annual compound rate method.

The "adjusted" figures can be interpreted as an answer to the question: "How would U.S. real estate figures behave if output were measured using a CIA-like index of total housing area." The "adjusted" figures are not an exact answer to that question because they are obtained using a units index, not a total area index. The difference between these two indexes is the growth rate of area per unit. Direct measures of the growth rates of total area or area per unit are unavailable; the U.S. government does not calculate the U.S. housing area (or the area of a "representative" unit). However, an indirect approach can yield general results.

A stock-flow equation suggests that the growth rate of area per *new* unit can be interpreted as a maximum, upper-bound on the growth rate of area per unit (9, p. 139–140).[8] The 1982–1985 growth rate of area per *new* unit is either 0.52 percent or 0.34 percent (depending on whether the least-squares or the compound rate method is used). So the units index is an imperfect but reasonable proxy for the (unmeasured) area index. A very large part of the 2.10 percent difference between the long-term BEA and "adjusted" growth rates is due not to units getting "bigger" but to improvements in quality per square foot.

The lack of data prevents a comparison between U.S. and Soviet housing areas. However, interesting comparisons can be made using data on the number of housing units.

Morton presented data for over twenty OECD and East European countries (8, p. 797). For the United States (in 1965) there were 68,679 thousand units, resulting in 97 households per 100 units. In the Soviet Union (in 1970) fewer units (59,202 thousand) were available for an even larger number of households, resulting in 123 households per 100 units (second only to Bulgaria's 125 households per 100 units for the countries examined). Morton wrote: "An estimated thirty percent of the urban population still either live communally, with unrelated families and single sharing apartments, or in crowded factory dormitories" (8, p. 790). Statistics such as these support the conclusion that Soviet housing is crowded by Western standards.

A comparison at a moment in time between Soviet and U.S. conditions is interesting and valid. But as stressed in Section I, the level of housing quality is a concept that differs from the growth rate of housing quality. In the following Soviet case study, this is examined in detail, showing that considerable improvements have been achieved in the post-WWII period.

IV. The Soviet Case Study

The CIA's index of total square meters does measure one aspect of quality change for housing units: the growth in area per unit. If quality per *square meter* has grown, the growth rate of area underestimates the growth rate of output. The CIA clearly recognizes this problem since the agency reports, "Presumably, an index based on housing space alone understates the real gains by failing to capture qualitative improvements" (20, p. 344). However, the CIA goes on to

[8]The idea behind the mathematics is that when the "marginal" (area per new unit) is above the "average" (area per existing unit), the average rises, but not to the level of the marginal.

argue that "there is little evidence to show that the physical quality of housing construction *per se* in the U.S.S.R. has improved much over the years" (20, p. 344). The CIA is suggesting, in effect, that the growth in quality per square meter is zero. Therefore, in order to demonstrate the need for an alternative index, it is first necessary to show that quality per square meter has in fact risen. A brief survey of some of the major changes in the location, design, and amenities of Soviet housing constitutes evidence that Soviet housing characteristics have changed rapidly.

One outstanding feature of Soviet housing in the postwar period is the tremendous shift in the composition of the housing stock toward urban housing. The data on rural and urban housing from which the CIA constructs its housing index (20, pp. 386–392) show the change in terms of square meters. In 1950 the percentage of square meters of urban housing as a fraction of total square meters was 38.4 percent; in 1960 it was 48.1 percent; in 1970, 59.4 percent; and in 1980 it had reached 62.3 percent.

In the economic literature on housing demand, location is considered to be a major characteristic of a housing unit although it is not "embodied" in the materials of the unit. Even if location were not considered to be a characteristic of housing, it could be viewed as a proxy for such characteristics: urban housing has "better" characteristics than rural housing. In 1979, Morton wrote:

> While most urban housing comes equipped with electricity, indoor plumbing, hot water, gas and central heating, in rural areas, although the typical privately owned one-story wooden home will have electric current, water is drawn from a well and an outhouse is used instead of a flush toilet (8, p. 790).

The geographical shift in the composition of Soviet housing is relevant for recognizing improvement in Soviet housing quality.

Another housing characteristic that has changed has been the average height of residential buildings. The average height of *new* state-owned housing has shown remarkable growth, and this change affects the (unobserved) average height of the housing stock. Smith reports, "As recently as 1965 only 5.5 percent of the housing built by the state was over five stories but by 1970 had reached almost 19 percent" (10, p. 412). The share of new buildings over five stories tall was only 1.0 percent in 1961 (10, p. 412), so the increase to 18.9 percent in only nine years is enormous. Six years later, in 1976, "approximately 30 percent of the annual program consisted of *nine*-story tall buildings" (29, p. 31, emphasis added). Therefore the 1976 share of new buildings over *five* stories tall exceeded 30 percent, representing another large gain compared to the 18.9 percent figure for 1970. The construction of even taller 12–16 story buildings is spreading (29, p. 31). When the average height of new buildings is above the average height of existing buildings, the average height of the stock is increasing.

The increase in the height of residential buildings is closely related to increases in housing quality. One Soviet article noted, "The increase in the expenditure of metal per unit of area and the growth of concrete intensiveness are to a considerable degree the result of high-rise housing construction" (29, p. 31). Since there are "decreasing returns to vertical scale", so to speak—at least

for housing of the relevant (Soviet) design and of the relevant height—the quantities of metals and of concrete and, no doubt, of other resources increase more than in proportion to height. Thus, a square meter of housing in a tall building *absorbs more resources* than a square meter in a low building. As the share of the housing stock taken by tall buildings increases over time, an index of square meters underestimates the growth in the welfare-generating resources absorbed by housing.

Changes in a wide variety of other characteristics have occurred as well. In 1979 a Soviet article reported:

> In the last 15 years there were qualitative changes in housing construction: primary emphasis has been on the construction of single-family apartments (90-95 percent), the area of auxiliary buildings was increased, the configuration and soundproofing of apartments increased, etc. There has been an increase in the number of floors of residential buildings and in the number of buildings with elevators and rubbish chutes (5, p. 38).

The CIA observed that "state urban housing has been increasingly provided with amenities—baths, hot water, plumbing and electricity—(although) most rural housing and probably some private urban housing still lack all of them except electricity" (20, p. 344).

Perhaps no other physical changes in housing have been as important to the Soviet population as the provision of such utilities. The CIA does not discount the impact these changes have had on the welfare of Soviet people, but after noting that the amenities of urban public housing have grown over time, the CIA argued, "most of this aspect of improvement in housing conditions is captured in the index for utilities" (20, p. 344). (Utilities is a distinct industry in the CIA's Soviet accounts.) In the national accounts of a Western country, the spread of utilities would indeed be reflected in the output of utilities industries, as the CIA suggests. However, as the proportion of (for example) electrified homes increases, housing output (measured by a weighted index) grows more quickly than it otherwise would because the number high-quality electrified homes is growing faster than the number of low-quality homes. Therefore an adjustment for quality change due to the provision of utilities is also appropriate for the Soviet housing index.

The evidence just presented suggests that the growth rate of resources absorbed by housing has exceeded the growth rate of housing area. If the welfare interpretation of GNP is adopted, an additional theoretical step is needed to show that quality (per square meter) has risen.[9] This step is one that is not foreign to neoclassical thinking. Interestingly, it can even be found in a Soviet article which explicitly recognized the connection between resource cost and the flow of housing services.

[9]The productive capacity interpretation of GNP conceives of real GNP growth as an outward shift in the economy's Production Possibilities Frontier, which is defined for given levels of resources. To those economists who adopt this interpretation of GNP, evidence that housing absorbs more resources is sufficient to show that quality has increased.

> The improvement of the quality of housing construction has been accompanied by growth in its cost; our state accepts these expenditures, since they are associated with improvement not only in the quality of housing but also in the population's living conditions an increase in the level of comfort (6, p. 31).

Since there is not a free market in housing in the Soviet Union, we cannot observe rent differentials that would be direct evidence of consumers' valuation of various types of housing units.[10] However, it is possible to infer that welfare has increased even without direct observations on prices and quantities of various housing units. If the resource devoted to housing did *not* contribute to welfare, then why were the resources diverted from their alternative uses? The implication is that direct evidence of increases in resource cost constitute indirect evidence of increases in welfare.[11] The problem is how to make a quality adjustment for improvements in Soviet housing.

Bergson developed a quality-adjusted housing index that combined square meters for three separate categories of housing: public housing, private urban housing, and private rural housing (2, p. 54). The 0.4 relative weight (relative to public housing) for the private urban series was taken from a Russian source that was "not especially explicit about the nature of the values in question. Very likely they are intended to represent depreciated 1936 reproduction costs" (2, pp. 315–316). The 0.2 relative weight for the private rural series was "quite arbitrary." If more recent data on housing costs could be located, the CIA could use Bergson's procedure for the postwar housing index. This would result in a quality-adjusted index for housing, but as is true of any weighted index, only the quality changes due to inter-category shift of housing are detected. As the evidence in this section shows, the intra-category improvements (e.g. within state housing) of Soviet housing have been significant. The ideal housing index would distinguish many more than three categories in order to account for the quality improvements that occur within the three broad categories listed above. In the context of Soviet housing, if only three categories can be distinguished, a weighted index is likely to be downward biased to a very large extent.

This paper uses an alternative approach for measuring the output of Soviet housing. An index of the value of capital (in constant prices) invested in Soviet housing is used to extrapolate the base year output of housing. In order to evaluate

[10]Soviet authorities charge a single rental rate (per square meter) for state-owned housing (5, p. 39), and it is a rate that is so heavily subsidized by the state that "it covers only about one third of total maintenance costs" (20, p. 344). Recently, Soviet authorities were developing plans for having rental rates "depend more closely on the quality of the building" (28, p. A37). The extent to which this reform is implemented remains to be seen.

[11]It is possible that either planners do not have good information on consumers' preferences, or that the planners have preferences that diverge from consumers' preferences. In either case, there would be no reason to suppose that planners have maximized the utility of the representative consumer subject to a given level of resources devoted to Soviet housing. For example, Soviet consumers may prefer to have more kitchens and fewer bathrooms than planners have provided, but only an extreme argument would propose that planners' and consumers' preferences diverge so much that the increase in planners' welfare due to increases in housing's characteristics is associated with a *decrease* in consumer welfare. If this extreme argument is rejected, then increases in direct measures of resource cost are indirect measures of welfare gains for consumers.

the accuracy of an index of housing capital, it is necessary to consider housing characteristics in greater detail.

King (4) conducted a cross-section study of the prices of homes sold between 1967 and 1970 in the New Haven, Connecticut area. Equation 1 is an adaptation of an equation presented by King (the notation of which is changed slightly here).

$$(1) \qquad P_k = \sum_{i=1}^{N} a_i * SC_{i,k} + \sum_{j=1}^{M} b_j * LC_{j,k} + c * L$$

In (1) P_k is the sales price (asset price) of the kth housing unit. The SC vector represents "structural components" (as examples King gave the "number of rooms" and the "quantity of insulation"), the LC vector represents "location components" (as examples King gave "access" to the Central Business District and "neighborhood quality"), and L represents the quantity of (presumably, homogeneous) land (4, p. 458). The weights on the elements of SC and LC represent the price per unit of the characteristic, and the weight on L represents the price per unit of land. A similar equation would be applicable to housing rents, which are the price of the flow of housing services per unit time.[12]

An index of housing capital has certain properties that make it very useful as a measure of housing output. An index of housing capital—unlike an area index—will reflect the levels of *all* of those housing characteristics which King called "structural" housing components. Structural characteristics are "made from" capital jelly. Some *part* of Soviet housing capital has been devoted to increasing area per unit, the aspect of quality which the CIA's area index includes, but some fraction of housing capital is invested in other structural characteristics.

Two factors create a wedge between the growth rates of housing capital and the growth rates of housing output. First, the value of housing output can be thought of as the product of two terms: the value of the stock of housing capital and the capitalization rate appropriate for housing. If the capitalization rate changes over time, the growth rates of capital and output will diverge. More specifically, if the capitalization rate increases, the growth rate of output will exceed the growth rate of capital. Second, as Equation 1 shows, there are factors that influence housing prices that are not attributable to structural characteristics or, in turn, to capital. The presence of these factors can create differences between the growth rates of output and capital.

It is useful to have theoretical reasons for believing that output and capital growth rates will have a positive correlation. These reasons provide some justification for using an index of Soviet housing capital to measure Soviet housing output. Since theoretical arguments are bolstered by data, it is worthwhile to compare figures on housing output and housing capital. Such a comparison is

[12]Some of the coefficients that King estimated (4, p. 469) are of interest. On average, a house that contained a partial bath sold for $1,000 more than it otherwise would have. A house that had steam heat obtained a price differential of about $600. A house that was 100 square feet larger than an otherwise identical house sold for about $670 more. A house that was over one-story tall sold for $110 more than a house with equal amounts of area and other characteristics. These characteristics and others affect welfare and resource cost in Soviet housing, although the relative values of characteristics need not be the same in the U.S. and the Soviet Union. The nominal dollar values of housing characteristics would be far larger today than the figures reported above because King's study was conducted using data from the late 1960's.

not done here for the Soviet Union because the problem at hand is to develop a good proxy for output in the first place. Nonetheless, the relationship between the growth rate of U.S. Real Estate output and U.S. Real Estate capital can be shown to be quite close.

The BEA output figures for real estate are the combined figures for SIC 65 and SIC 66. The BEA reports capital figures separately for total residential capital and for fixed private capital used in real estate. In this paper the author uses the sum of the two estimates for a given year as an annual estimate of all capital used in Real Estate. The BEA measures constant-dollar gross capital stocks and, using straight-line depreciation, constant-dollar net stocks. The (end-of-year) capital figures for 1949–1980 were taken from (22, pp. 56–59, 66–67), while figures for 1983–1984 were taken from (23, pp. 37–38). Estimates of the mid-year stock of real estate capital were obtained by logarithmic interpolation using successive end-of-year stock figures.

The annual average compound growth rates of BEA output figures by five-year intervals and for the 1951–1984 period is shown in Table 3. Also shown are the growth rates of gross capital and net capital, as well as the growth rate of the number of units (from Table 2).

In Table 3, it is shown that the growth rate of capital has exceeded the growth rate of units by considerable margins, indicating a rapid rise in capital per unit. The growth of capital per unit is tantamount to a growth in the quality of a housing unit because over time a representative unit is absorbing more resources. The changes in specific structural characteristics, such as size or heating or plumbing, are not measured by a capital-units ratio, but growth in capital per unit is an excellent statistic that summarizes these many changes in a single figure.

If an index of U.S. housing units were used as a proxy for housing output, the growth rate of U.S. real estate would be severely underestimated, a result which is demonstrated in Section III of this paper. An index of housing area would be better (if one were measurable), and (as shown in Table 3) an index of housing capital would be better yet. Nevertheless, for the United States, capital is a systematically biased proxy for output. In every period except 1981–1984,

TABLE 3

U.S. Real Estate Data

(Average annual growth rates)

Period	BEA Output	Gross Capital	Net Capital	Number of units
1951–55	6.20	3.47	4.56	2.75
1956–60	5.82	3.50	4.27	2.05
1961–65	5.29	3.46	3.98	1.97
1966–70	4.02	3.13	3.28	1.71
1971–75	4.07	3.38	3.51	2.03
1976–80	3.68	2.90	2.77	2.17
1981–84	1.82	2.30	1.91	2.01
1951–84	4.48	3.19	3.51	2.10

the growth rate of output exceeds the growth rate of capital, regardless of whether net or gross capital figures are considered.

On the basis of this theoretical and empirical investigation, there is good reason to believe than an index of Soviet housing capital is a better proxy for housing output than the CIA's index of square meters. Furthermore, it may be that the Soviet housing capital index underestimates the "true" growth rate of Soviet housing output—just as the growth rate of U.S. housing capital is below the growth rate of U.S. housing output.

One problem does arise when Soviet housing capital data—or any Soviet capital data—are used. A CIA report that considered the accuracy of Soviet capital data noted the close agreement between quasi-independent Western estimates of growth rates of Soviet capital and the rates implied by Soviet figures on the stock. This close agreement lends credibility to the official Soviet figures. However, the report mentioned the possibility that both sets of growth rates contain inflation to some extent (19, pp. iii-iv). Although the rate of inflation was thought to be small, some degree of inflation is present in the official figures. This inflation is probably present in all categories of Soviet capital, including housing capital.

The housing capital index used to estimate "adjusted" Soviet housing output was based on gross capital figures available from (19), and extended for 1980–1984 using figures from *Narkhoz 1984* (27, p. 60).[13] End-of-year capital stocks were converted to mid-year capital stocks by logarithmic interpolation. Mid-year

TABLE 4
SOVIET HOUSING OUTPUT
(Millions rubles)

Year	(1) "Adjusted" Figures	(2) CIA Figures	(3) Difference (2)-(1)	(4) Relative Difference (3)/(2)
1950	7.7	13.3	−5.6	−42%
1955	10.4	15.3	−4.9	−32%
1960	16.1	19.6	−3.5	−18%
1965	21.6	23.8	−2.2	−9%
1970	27.7	27.7	0.0	0%
1975	36.2	31.6	4.6	15%
1980	46.0	35.3	10.7	30%
1984	55.7	38.9	16.8	43%

[13]The "adjusted" Soviet housing index was based on gross capital stocks because these data were readily available on an annual basis. There are depreciation factors, reported in *Narkhoz 1959* (27, p. 75), that relate gross and net capital stocks for various Soviet industries, but these factors could be located for only a single year. If these depreciation factors had been used to construct a series of net housing capital stocks (using the same depreciation factor for all years), the growth rates of the resulting figures would be numerically identical to the growth rates of gross capital stocks that this paper used.

capital stocks were then converted to indexes using 1970 as the base year, and this index was used to extrapolate the CIA's (1970) base year estimates of Soviet housing output in order to obtain "adjusted" housing output. (The CIA has now developed Soviet accounts that use 1982 as the base year.)

The "adjusted" output figures and the CIA output figures, in millions of rubles, as well as their differences and relative differences (as percentages of the CIA's output figures) were calculated for 1950–84. The figures by five-year intervals (except for 1980–1984) are presented in Table 4.

The relative difference between "adjusted" and CIA output figures is −42 percent for 1950. It reaches zero (as it must, by construction) in 1970, and then it grows to 43 percent in 1984. So within 15 to 20 years of the base year, the output figures that result from the two different indexes differ considerably.

Growth rates, by five-year intervals and for 1951–1984, of "adjusted" and CIA output, as well as their differences and their relative differences are shown in Table 5.

The growth rates of "adjusted" housing output exceeds the rate of CIA figures in every period. The differences range from a low of 2.02 percent to 4.05 percent. The relative differences exceed 100 percent in some periods, although on a long-term basis the relative difference between the "adjusted" and CIA 1951–1984 growth rates is 87 percent. The 1951–1984 growth rate of "adjusted" output is 5.99 percent, which is 2.78 percent above the 3.21 percent growth rate of CIA output. The relative difference of 87 percent between the two figures is sizeable: the growth rate of output nearly doubles when a capital index (which captures many aspects of quality improvement) is substituted for an area index (which measures but one type of quality improvement).

TABLE 5

GROWTH RATES OF SOVIET HOUSING OUTPUT

(Average annual)

Period	(1) "Adjusted" Figures	(2) CIA Figures	(3) Difference (2)-(1)	(4) Relative Difference (3)/(2)
1951-55	6.20	2.84	3.36	118%
1956-60	9.13	5.08	4.05	80%
1961-65	6.05	3.96	2.09	53%
1966-70	5.10	3.08	2.02	66%
1971-75	5.50	2.67	2.83	106%
1976-80	4.91	2.24	2.67	119%
1981-84	4.90	2.46	2.44	99%
1951-84	5.99	3.21	2.78	87%

V. SUMMARY AND CONCLUSIONS

In this paper the author has conducted two case studies on the measurement of housing output. The basis for these case studies was the observation that

"housing" is a heterogeneous commodity: different housing units have different characteristics and therefore have different amounts of quality. Indexes which measure the output of the housing industry will reflect quality improvements to a greater or lesser degree. It can be expected that the annual levels and growth rates of housing output are affected by the use of different indexes. The numerical magnitudes of these effects were investigated in this paper.

In the U.S. case study, an "adjusted" housing index was constructed using the number of U.S. housing units. When "adjusted" real estate output is measured using the units index, the resulting output figures completely omit housing improvements. Not surprisingly, the growth rate of "adjusted" figures is far below the growth rate of the BEA real estate figures. Due to this difference, "adjusted" output is below (above) BEA output in years that follow (precede) the base year. The long-term 1951–1984 growth rates of BEA and "adjusted" output are 4.48 percent and 2.10 percent, which represents a difference of 2.38 percent or 113 percent of the "adjusted" growth rate. So, for the U.S. real estate industry, the growth rate of output doubles when quality growth is taken into account. The relative difference between the 1950 levels of "adjusted" and BEA output was −52 percent, although the relative difference is smaller for years closer to the (1982) base year (as it must be, by construction).

The Soviet case study argued that the growth rate of Soviet housing quality has been both positive and large. A novel approach for measured quality-adjusted housing was introduced. Theoretical reasons for using an index of housing capital to measure housing output were offered, and data for U.S. housing supported the proposition that a capital index would reflect a large amount of housing quality. In the Soviet case study an index of Soviet housing capital was then used to measure "adjusted" housing output. The relative difference between the levels of "adjusted" and CIA output was −42 percent for 1950, fell to 0 percent for the (1970) base year, and rose again to 43 percent by 1984. The 1951–1984 growth rates of "adjusted" and CIA output were 5.99 percent and 3.21 percent, respectively, making a relative difference of 87 percent. So the growth rate of Soviet housing output nearly doubles when quality-growth is reflected in the housing figures.

Even if the distinction between the level and growth rate of housing quality is kept in mind, an increase in the growth rate by 87 percent to 5.99 percent is quite large and perhaps some do not believe this result. However, the U.S. case study reported a similar figure that resulted from a similar experiment. Since it was shown first that U.S. housing growth falls by half when quality growth is omitted, it is less surprising that the Soviet housing growth rate approximately doubles when a large amount of quality growth is added in.

The most important conclusion to draw from this paper is that economic "facts" are sensitive to measurement procedures. Even a concept as basic to economics as "output" is subject to a variety of interpretations, depending on the extent of quality adjustment that is introduced.

The measurement of "output" for the U.S. and Soviet economies must be done quite carefully in order to ensure that comparisons do not systematically increase one country's growth rate relative to the other. Comparable output figures are the basis for studies of the structure, conduct, and performance of the two

economies. The CIA does an excellent job of developing real GNP accounts for the Soviet economy. It is hoped that this paper may make a small contribution to the CIA's work, and to the work of all those who develop and use national accounts.

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