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APPENDIX E

ANNUAL CAPITAL CONSUMPTION ALLOWANCES

ANNUAL capital consumption estimates, necessary to pass from gross to net capital formation, are here considered to comprise a depreciation charge covering physical deterioration plus obsolescence and allowing for demolitions of all types, the latter being of small magnitude compared with the former. Fire losses have been ignored, since, apart from the difficulty of obtaining usable data, in the overwhelming majority of instances damages due to fire are minor and reparable; expenditures for repairs, however, do not constitute part of gross capital formation. Where fires result in total or nearly total destruction the loss is presumably captured in the demolition allowances. Although borderline cases can be identified, especially if expenditures on damage restitution are included in additions and alterations, any error involved would be quite small compared with total capital consumption.

The Annual Depreciation Charge

Since capital consumption, over 90 per cent of which is depreciation, is an increasing charge against gross capital formation, the selection of a proper rate and a proper formula for depreciation is of great significance for the derivation and interpretation of the net capital formation series. Depreciation is defined here as the average annual diminution in the value of a structure as it ages. Statistically, the decline is considered to be most nearly approximated by the difference between the current value of an existing structure and the cost of reproducing an identical or nearly identical substitute.

A limited amount of empirical data exist in the work of Hoad, Goldsmith, and the FHA that permit measures of depreciation thus defined. These data support a now generally accepted belief that official Bulletin F and Department of Commerce depreciation formulas—linear depreciation at rates ranging between 2 and 3 per cent—overstate the amount and incorrectly describe the time distribution of actual depreciation. Residential structures have an economic life substantially longer than 33 to 50 years. In 1940 about 600,000 nonfarm dwelling units over 80 years old were still in productive existence, i.e. occupied, a number representing a substantial proportion of all nonfarm dwelling units built before 1860; dwelling units over 50 years old still standing in 1940 amounted to over one-third of the 1890 housing inventory. Nor does experience indicate that a specified finite physical life can be assigned to residential structures as is implied in the linear method. Rather, the life of a structure is indefinitely long and is terminated much more frequently by casualty or site obsolescence than by physical deterioration or structure obsolescence. Given average maintenance and repairs, few dwelling units become uninhabitable from the point of view of the housing market, however large the number may be when certain social standards of habitability are applied. In 1950, of 3,145,000 nonfarm dwelling units reported to be dilapidated, only 321,000 were vacant; and of this number, many were undoubtedly still on the market.

Hoad's study indicates that houses 50 years old have experienced an average decline in value of .6 per cent a year.[1] These data were derived from two samples of single-family houses of different ages, bungalows, and 1½- to 2-story frame houses—all of which were sold on the open market and for all of which market prices could be obtained. The average market price of each age class, expressed as a ratio to the price of a comparable new house, indicates that 50-year-old bungalows had suffered a 35 per cent loss in value and 50-year-old frame houses a loss of 26 per cent, equivalent to average linear rates of .7 per cent and .5 per cent respectively. The depreciation curves, especially for bungalows, are nonlinear, showing a relatively greater value decline in early than in later life.

Hoad's derived depreciation rates are quite minimal and, for a number of reasons, seriously understate actual depreciation. In the first place, the decline in value for structures exclusive of land appears to be greater than for houses inclusive of land. The decline in total value tends to be slower because land constitutes a higher proportion of the value of older houses (Table E-1, column 9), either due to original location or due to the effects of city growth. Second, the price ratio of old houses to new houses understates the decline in value from actual reproduction cost. No matter how careful the attempt at sample homogeneity may be, the fact remains that in an empirical study of market sales it is exceedingly difficult to obtain structure comparability. Older houses, especially those coming into the market, tend to be larger than newer structures, containing basements, more rooms, etc.[2] These two biases can be illustrated by the FHA data shown in Table E-1. The decline in value for houses and land indicates a substantially lower depreciation rate (at fifty years) than for structures alone, .65 per year compared with .82.[3] The nature of the second bias is seen by

[1] William M. Hoad, "Real Estate Prices, A Study of Residential Real Estate in Lucas County, Ohio," unpublished doctoral dissertation, University of Michigan, 1942.

[2] George Katona, "Relevant Considerations in Recent Housing Purchases," unpublished preliminary report to the Housing and Home Finance Agency, June 1951.

[3] Thus the oldest houses (including land) show a decline in value of about one-third relative to the newest houses, \$4,033 compared with a 1935-1938 average

TABLE E-1
Selected Characteristics of a Sample of Existing Single-Family Houses Securing Mortgages Insured by the FHA, September-December 1939

Year Built (1)	*Total FHA Property Valuation* (2)	*FHA Value of House* (3)	*Estimated Current Replacement Cost* (4)	*FHA Land Value* (5)	*Age in Years* (6)	*Ratio of Current Value to Replacement Cost* (7)	*Average Annual Decline in Value* (8)	*Land Ratio* (9)
1938	$5,851	$4,703	$4,935	$ 849	1	95.3%	4.7%	14.5%
1937	5,543	4,505	4,766	779	2	94.5	2.8	14.0
1936	6,440	4,989	5,640	1,107	3	88.5	3.8	17.2
1935	6,452	5,089	6,187	1,070	4	82.3	4.4	16.6
1930-1934	5,518	4,368	5,506	904	7	79.3	2.9	16.4
1925-1929	5,024	3,864	5,321	946	12	72.6	2.3	18.8
1920-1924	4,846	3,596	5,492	1,029	17	65.5	2.0	21.2
1915-1919	4,608	3,427	5,992	994	22	57.2	1.9	21.6
1910-1914	4,698	3,393	6,002	1,085	27	56.5	1.6	23.1
1900-1909	4,212	3,127	5,978	929	34	52.3	1.4	22.1
Pre-1900	4,033	2,788	7,766	1,063	52	35.9	1.2	26.4

Column	Source
1-5	Federal Housing Administration, Division of Research and Statistics, Operating Statistics Section. Column 2 includes the value of minor structures, chiefly garages, and is therefore greater than the sum of column 3 and column 5. The FHA sample represents every third insured case received from field offices during the last four months of 1939. The geographical distribution of the sample (by states) conforms to all properties insured during 1939 under Section 203. The general procedure used by FHA appraisers for separating land and structure value is to (1) appraise the total property, (2) estimate the value of land by sales comparison with allowances for special factors, (3) subtract the value of land from total property value, leaving structure value as a residual. *FHA Underwriting Manual*, 1938, paragraphs 1361-1369.
6	From column 1. For grouped year-built data, age is counted from class midpoints. The midpoint of the open-end class was determined from the *Census of Housing 1940* (Bureau of the Census, Vol. III, *Characteristics by Monthly Rent or Value*, p. 15), which indicates that the median year built for single-family owner-occupied houses built before 1900 was 1887.
7	Ratio of column 3 to column 4.
8	Difference between column 7 and 100 per cent divided by column 6.
9	Ratio of column 5 to column 2.

comparing the value of old structures to that of new structures without regard to physical comparability. The resulting measure of value decline is lower than when value decline is measured from the estimated cost of reproducing a similar structure, 42 per cent compared with 64 per cent. The possibility of a third bias, arising from the fact that houses which pass through the market may have been subject to less than an average amount of obsolescence and more than an

value of $6,072 (Table E-1, column 2). Excluding land, the value decline is 42 per cent, $2,788 compared with $4,822 (column 3).

average amount of maintenance and alteration, also deserves mention.

Goldsmith obtained a linear depreciation of 1.1 per cent from evidence of a 50 per cent decline in value for forty-five-year-old houses.[4] The rate is based on data collected by Wickens from a sample of owner occupants in a number of cities.[5] While owners' estimates of value or age of structure may not be particularly trustworthy, the results are nevertheless useful because the data were not restricted to houses coming into the market and because of the wide geographical coverage. The assumption by Goldsmith of a constant land ratio for each age class and the lack of structure comparability may tend to understate the depreciation rate as it has been defined here.

The most usable data, in form and quality, are contained in a sample of 1,500 single-family houses appraised by the Federal Housing Administration during 1939 (Table E-1). Not only have land and structure values been separately appraised, but an estimated cost of reproduction is assigned to the structures in each age class. Furthermore, the reliability of both the current-value and reproduction cost estimates, made by experienced appraisers operating under uniform instructions and methods, is at least as high as one is likely to obtain in the thorny field of valuation.

These data indicate that structures somewhat older than fifty years (fifty-two years) had an average current value of less than 36 per cent of the average cost of reproduction, equivalent to the result of an average annual linear rate of depreciation of 1.2 per cent. More detailed analysis of the value decline by age class indicates, however, a pronounced curvilinear pattern in the form of a curve convex to the origin.

A number of factors in connection with these sample data need to be considered before establishing a final rate. (1) A depreciation rate derived from 1939 value data is likely to be higher than would be found in a period of high activity. That is, the rate of depreciation probably is not cyclically constant; the value discount applied by the market because of age of structure may vary with market conditions. Hoad's data, derived largely from the twenties, would imply a lower depreciation rate even after allowance is made for their inherent downward bias. (2) The eligibility requirements imposed by the FHA, on the other hand, may result in the same "marketability" bias discussed earlier, namely, that the sample structures may have experienced less

[4] Raymond W. Goldsmith, "A Perpetual Inventory of National Wealth," in *Studies in Income and Wealth, Volume Fourteen,* National Bureau of Economic Research, 1951, pp. 21-24.

[5] And published in *The Financial Survey of Urban Housing,* Dept. of Commerce, 1937.

than average obsolescence and that such structures have received better-than-average maintenance and repairs as well as at least an average amount of additions and alterations. The inclusion of expenditures for additions and alterations in gross capital formation requires an upward adjustment in any depreciation rate affected by such a value increment to avoid an overstatement in net capital formation. (3) The rate is derived from single-family houses. Consideration must therefore be given to other types of structures. Multi-family structures are generally thought to decline in value somewhat more rapidly than single-family structures.

Making the best estimates possible with the help of the scanty available data on the magnitude of these adjustments, a rate of 1.4 per cent to be applied to the aggregate housing inventory would appear to be reasonable if a linear formula were to be assumed. The weight of evidence is against such an assumption. Furthermore, a linear formula, which is dependent on original costs, requires the estimation of annual residential construction expenditures and construction cost indexes back to the early nineteenth century before capital consumption for the year 1889 can be calculated. Such estimates cannot be made without wide margins of error.

Although curvilinear depreciation can be accomplished in a number of ways, a constant percentage applied to each year's cumulated structure values is more reliable than depreciation based on original cost. By our method, depreciation for 1889 is computed by applying the selected depreciation rate against an independently derived estimate of the net value of structures in existence on January 1, 1889; and for all subsequent years, by cumulation of net capital formation. Derivation of this initial value estimate is given in Appendix D.

While a precise determination of the level of such a constant rate is difficult, 2 per cent appears to be a satisfactory approximation for a housing inventory having an average age during the period covered of roughly 20 years and compares with a linear rate of 1.4 per cent. For any individual structure, the linear rate leads to total extinction of value at the end of 70 years. Under the declining balance method a 2 per cent rate results in a remaining value of 25 per cent of original cost at the end of the same period of time and an indefinitely lingering life. Over the first 40 years of life the total depreciation charge is about the same under either procedure but the time distribution is somewhat different, the declining balance method yielding a higher depreciation charge during the first two decades and a lower depreciation charge during the second two decades. The difference in the aggregate depreciation charge in any year will depend on the age distribution of the housing inventory.

The depreciation scheme adopted also differs from conventional linear depreciation by taking into account the changing price level of capital assets. As the housing inventory is revalued annually, each year's current-price capital consumption allowance, based on the current value of the inventory, is simultaneously revalued by the same index. Linear depreciation usually, but not necessarily, spreads the original cost over a given number of years without adjustment for price movements. Since real estate prices have had a strong upward trend, the depreciation allowances derived in this study when expressed in current prices are higher than those found in official national income accounts[6] but smaller in constant prices because of the lower rate used.

No depreciation formula can ever be completely satisfactory. Even the rate used in this study, for example, results in lower depreciation charges during early life than the FHA data seem to indicate. It is quite possible that a curvilinear procedure based on a varying rather than a constant rate would offer a more accurate description of value decline. Such a rate might also be varied with cyclical changes, changes in the proportion of multi-family structures, and with such special circumstances as undermaintenance during periods of rent control. A trend factor might be introduced to allow for the increasing proportion of structures containing wiring, plumbing, and other structural equipment subject to relatively high depreciation rates (Appendix I). Refinements of this kind, however, must await data superior to those now available. The constant-rate method at least avoids many of the pitfalls associated with a linear rate. Moreover, it is at least as easy to comprehend and even easier to use.

The 2 per cent rate, as has been stated, is applied to the value of the inventory at the beginning of each year. An additional half year's depreciation (at the same rate) is charged against each year's residential construction expenditures including additions and alterations, by assuming that annual gross capital formation is centered on the middle of each year.

Allowance for Demolitions

The capital consumption allowance for demolitions is based on the weakest of data since information on the volume of demolition, even for recent years, is notoriously poor. Decade estimates of the total number of dwelling units demolished have been made by Wickens for the period 1890-1929 and by the Bureau of Labor Statistics for the

[6] *National Income*, Dept. of Commerce, 1951 edition, pp. 80 and 203. In 1947 the depreciation allowance for tenant- and owner-occupied housing (the latter inclusive of farm housing) amounted to $2,503,000,000 compared with the $3,226,000,000 shown in Table E-2.

period 1930-1949.[7] These estimates are the starting point for the demolition allowances.

A ratio was derived of annual demolitions (taken as one-tenth of the total in each decade) to the average annual size of the inventory (taken as the average of the opening and closing inventories of each decade). These ratios, derived in terms of dwelling units, were then converted to value ratios by a one-third reduction. The reduction was based on the assumption that demolished dwelling units have a somewhat-lower-than-average value since (1) structures demolished because of supersession probably have a greater-than-average age and (2) a large proportion of losses due to storm, flood, and fire occur in rural nonfarm areas, where dwelling units are lower in value. These value ratios are shown in the footnotes to Table E-2.

The allowance for demolition is so small relative to total depreciation that it might have been totally ignored or dealt with, as others have done, by a slight increase in the depreciation rate. Separate estimation is justified less by any dubious gain in precision than by a desire to distinguish, conceptually, the two different kinds of capital consumption. The demolition of an occupied or inhabitable residential structure to make way for an office building, a public improvement, or even an apartment house does not represent the same kind of accelerated depreciation that occurs when a usable machine tool is rendered obsolete by the introduction of a newer type. In the latter case the relative efficiency of the existing tool is so sharply reduced as to give it zero (or scrap) value. In the case of site supersession the relative efficiency of the structure itself is not reduced; the demolition occurs because the structure cannot ordinarily be moved. Moreover, while a depreciation charge is viewed as a continuous and regular consumption of capital, demolitions due to supersession are probably quite irregular and related to causes which cannot be impounded within the phrase, "the passage of time."

Demolitions caused by casualty are more closely related to the concept of depreciation than those caused by supersession, since most of this destruction can be largely attributed to the action of the elements. There may also be sufficient actuarial regularity in the timing of such losses to warrant a slight elevation in the rate of depreciation. Yet for a number of reasons, aside from the fact that available data generally lump all types of demolitions together, even this form of capital consumption ought to be clearly distinguished from ordinary depreciation. For one, some writers prefer to treat catastrophic destruction

[7] See Appendix A.

TABLE E-2
Annual Capital Consumption of Nonfarm Housing, 1889-1953
(*millions of dollars*)

	CURRENT DOLLARS			1929 DOLLARS		
	Depreciation (1)	*Demolition* (2)	*Total Capital Consumption* (3)	*Depreciation* (4)	*Demolition* (5)	*Total Capital Consumption* (6)
1889	167	12	179	427	31	458
1890	181	13	194	463	33	496
1891	187	14	201	494	36	530
1892	193	14	207	525	38	563
1893	203	15	218	554	40	594
1894	205	15	220	579	42	621
1895	212	15	228	608	44	652
1896	223	16	239	635	46	681
1897	228	17	245	663	48	711
1898	247	18	265	687	50	737
1899	273	20	293	708	52	760
1900	294	23	317	723	57	780
1901	296	23	318	737	58	795
1902	313	24	337	754	59	813
1903	331	26	356	769	60	829
1904	334	26	360	787	61	848
1905	364	28	392	817	63	880
1906	418	32	450	854	66	920
1907	452	35	487	884	69	953
1908	451	35	486	911	71	982
1909	484	38	521	941	73	1,014
1910	516	43	559	969	81	1,050
1911	520	43	563	991	82	1,073
1912	546	45	591	1,014	84	1,098
1913	538	45	583	1,037	86	1,123
1914	554	46	600	1,062	88	1,150
1915	580	48	629	1,085	90	1,175
1916	633	52	685	1,110	92	1,202
1917	748	63	811	1,123	94	1,217
1918	885	75	961	1,118	95	1,213
1919	1,027	87	1,113	1,115	94	1,209
1920	1,325	119	1,443	1,116	100	1,216
1921	1,071	94	1,166	1,123	99	1,222
1922	1,014	89	1,102	1,156	101	1,257
1923	1,187	103	1,291	1,208	105	1,313
1924	1,235	107	1,342	1,275	110	1,385
1925	1,299	113	1,411	1,350	117	1,467
1926	1,384	120	1,504	1,428	124	1,552
1927	1,435	125	1,560	1,501	131	1,632
1928	1,502	131	1,633	1,566	137	1,703
1929	1,613	142	1,755	1,613	142	1,755

(continued on next page)

TABLE E-2 (continued)
(*millions of dollars*)

	CURRENT DOLLARS			1929 DOLLARS		
	Depreciation (1)	*Demolition* (2)	*Total Capital Consumption* (3)	*Depreciation* (4)	*Demolition* (5)	*Total Capital Consumption* (6)
1930	1,589	79	1,668	1,630	81	1,711
1931	1,468	73	1,541	1,633	81	1,714
1932	1,234	62	1,296	1,622	81	1,703
1933	1,221	61	1,282	1,602	80	1,682
1934	1,311	65	1,376	1,581	79	1,660
1935	1,261	63	1,323	1,566	78	1,644
1936	1,316	65	1,381	1,563	77	1,640
1937	1,468	72	1,540	1,567	77	1,644
1938	1,516	75	1,591	1,574	78	1,652
1939	1,555	76	1,632	1,587	78	1,665
1940	1,635	97	1,732	1,608	95	1,703
1941	1,791	105	1,896	1,634	96	1,730
1942	1,905	113	2,018	1,645	98	1,743
1943	1,978	118	2,096	1,632	97	1,729
1944	2,127	127	2,254	1,610	96	1,703
1945	2,240	134	2,374	1,590	95	1,685
1946	2,480	147	2,627	1,589	94	1,683
1947	3,050	180	3,230	1,612	95	1,707
1948	3,475	204	3,680	1,651	99	1,748
1949	3,465	202	3,667	1,696	99	1,795
1950	3,790	220	4,008	1,758	102	1,859
1951	4,229	244	4,473	1,823	105	1,928
1952	4,473	255	4,728	1,878	107	1,985
1953	4,681	267	4,947	1,931	110	2,041

Column	Source
1-3	Columns 4-6 transformed into current prices by construction cost index given in Table B-10.
4	Two per cent of the preceding end-of-year cumulated structural values given in Table D-1, column 1, plus 1 per cent of annual gross capital formation shown in Table B-6.
5	Same as source for column 4 except that the following ratios were used:

1890-1899	.15
1900-1909	.16
1910-1919	.17
1920-1929	.18
1930-1939	.10
1940-1953	.12[a]

[a] Based on an earlier estimate of 600,000 demolitions in 1940-1949, compared with the alternative estimate of 1,000,000 shown in Table A-1.

The rising trend in the demolition ratios through the first four decades is the result of an arbitrary assumption by David L. Wickens in his *Residential Real Estate* (National Bureau of Economic Research, 1941). The lower level of the ratios during the last two decades may be due to the shift in sources of data (Appendix A).

6 Sum of columns 4 and 5.

as an item of capital adjustment rather than capital consumption.[8] Second, the assumption of "natural" causation is valid only in the absence of war destruction. In the social accounting systems of less fortunate nations the loss of residential structures in wartime can hardly constitute an item of ordinary depreciation.

[8] Solomon Fabricant, *Capital Consumption and Adjustment,* National Bureau of Economic Research, 1938, p. 19.