Some information on the relative valuations of residential and other private assets using Bureau of Economic Analysis fixed assets data

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Abstract:

This paper presents information on the relative valuation of fixed assets, using data from the Bureau of Economic Analysis (BEA) coupled with observed longer-run historical relationships and "stylized facts" for macroeconomic relationships in the U.S. economy. Alternative scenarios are examined describing the likely extent of overvaluation of residential assets and the combination of real investment and price changes that would be required to resolve the overvaluation under varying assumptions. The scenarios presented illustrate how changes to the total nominal valuation of the asset stock typically are more easily accomplished through changes to the price of the asset than from changes in real investment flows, and this is particularly true for residential assets with their low depreciation rate. The approach provides a useful framework for the evaluation of alternative future paths and the scenarios presented provide useful benchmarks against which alternative combinations of changes in real investment and prices can be compared.

SOME INFORMATION ON THE RELATIVE VALUATIONS OF RESIDENTIAL AND OTHER PRIVATE ASSETS USING BEA FIXED ASSETS DATA

I. Introduction

Current concerns about housing markets in the United States have increased interest in understanding the relative valuation of fixed assets, notably determining the likely extent of overvaluation of residential assets and how that overvaluation might be corrected. Recent data have shown ongoing declines in housing starts and real residential investment and it is generally accepted that residential assets in the United States are experiencing a correction from excessive price appreciation in recent years. Much uncertainty remains, however, about the extent of overvaluation of residential assets and how that overvaluation will be resolved – that is, the likely paths for real residential investment and the prices of residential assets, and the interrelationships among real flows, prices and the relative nominal asset valuations.

An example of the expressed uncertainty about housing prices comes from a *Financial Times* report of an interview with Alan Greenspan:

> Mr Greenspan said he would expect "as a minimum, large single-digit" percentage declines in US house prices from peak to trough and added that he would not be surprised if the fall was "in double digits". Mr Greenspan said house prices were probably already down about 2-3 per cent from their peak on a national level. However, he cautioned that it was very difficult to predict how large the ultimate decline would be. (*Financial Times*, September 16, 2007)

Recent Congressional Budget Office (CBO) testimony included the following discussion about the outlook for housing prices:

> The outlook for home prices is highly uncertain, but it seems likely that house prices and, consequently, housing wealth will continue to fall next year. The inventory of unsold homes stands at high levels, which will place continued downward pressure on house prices in many regions of the country. Moreover, the ratio of housing prices to rents still seems very high relative to its history ... To be sure, homebuyers' expectations of home prices may deviate from long-term fundamentals for extended periods of time, and the price–rental ratio may therefore not provide a reliable guide to potential changes in prices over relatively short periods of time.

> Futures markets expect significant further declines in house prices. One measure, which looks at a constant-quality index of home prices in 10 metropolitan areas, anticipates a decline in nominal prices of about 7 percent over the coming year … However, the index may not indicate what is happening to prices nationwide. Another measure, from Radar Logic, Incorporated, a New York-based real estate and data analytics firm, with coverage of 25 metropolitan areas but with a less sophisticated adjustment for changes in the quality of the homes sold, projects a decline of 11 percent over one year and 24 percent over the next three years. Those expectations may also not be a reliable guide, however, because those contracts do not trade frequently or in large numbers and therefore may not represent a broad consensus of investors.
>
> Private forecasters differ widely in their projections of the decline in house prices, although all agree that there is a substantial decline still to come. Macroeconomic Advisers projects a 6 percent decline over two years, while Global Insight projects a similar decline over the next year. Goldman Sachs projects a 15 percent total decline before an upturn occurs—perhaps as much as a 30 percent decline if a recession occurs. (CBO (2007))

Gallin (2004), for example, has identified a relationship between the price-rental ratio and subsequent price changes, indicating that the high price-rental ratio of recent years will tend to be associated with subsequent declines or slower growth in prices.

The approach adopted in this paper for gaining additional information on the extent of overvaluation – and the combination of real investment and price changes required to resolve that overvaluation, as well as the possible timing – is to use fixed assets data from the Bureau of Economic Analysis (BEA) coupled with observed longer-run historical relationships for relative valuations of the fixed assets. The analysis of the overvaluation of residential assets by its nature presents severe limitations on any empirical analysis; effectively there are only a couple historical observations of such overvaluations on which to base any analysis. The analysis presented in this paper uses a number of assumptions and empirical conveniences that do not have fundamental theoretical foundations, but that are consistent with long-observed "stylized facts" and macroeconomic relationships in the U.S. economy. As such, the results and interpretations presented should be viewed as rough descriptions of the likely overvaluation of residential assets and the possible paths for real investment and prices that would be consistent with, or reasonable for, resolution of that imbalance. The approach provides a useful framework for evaluation of alternative future paths and the scenarios presented provide useful benchmarks

against which alternative combinations of changes in real investment and prices could be compared.

The approach and analysis of this paper may be particularly informative because of the explicit accounting of the combination of real investment and price changes in determining the nominal valuation of fixed assets. Changes in the level of the nominal valuation of assets – and corrections of overvaluations or under-valuations – can occur because of changes in the real flow of net investment (i.e., accounting for depreciation as well as the real investment flow) *or* because of changes in the price of the asset. The scenarios presented illustrate how changes to the total nominal valuation of the asset stock typically are more easily accomplished through changes to the price of the asset than from changes in real investment flows. Further, this is particularly true for assets such as residential structures that have such low depreciation rates.

II. BEA Fixed Asset Accounting Relationships

Fixed assets data from the Bureau of Economic Analysis (BEA) provide a useful basis for evaluation of historical relationships and, ultimately, for the alternative future paths for real investment and prices.[1]

Asset Levels:

The basic equation for the year-to-year evolution for the level of the nominal (current cost) value of the net stock of fixed assets (BEA (2003)) is:

$$(1) \quad K_{j,t} = K_{j,t-1} + i_{j,t} - d_{j,t} + v_{j,t}$$

where:

$K_{j,t}$ is the nominal value of the capital stock of asset j at the end of period t;

$i_{j,t}$ is the nominal investment flow for asset j during period t;

$d_{j,t}$ is the nominal depreciation for asset j during period t;

[1] At the time this paper is being written, fixed asset data are available through 2006 and preliminary NIPA data for GDP and components is available for 2007.

$v_{j,t}$ is the residual, nominal revaluation change for asset j during period t.

(Note that in the equations presented in this paper, upper case letters generally represent "stock" values, lower case letters represent "flows", and greek letters represent parameters.)

The nominal stock is equal to the price of the asset ($P_{j,t}$) times the real stock ($X_{j,t}$):

(2) $$K_{j,t} = P_{j,t} X_{j,t}$$

And, long-run equilibrium levels are given by (equilibrium values denoted by "bar" over variable):

(3) $$\overline{K}_{j,t} = \overline{P}_{j,t}\ \overline{X}_{j,t}$$

<u>Flows</u>:

The nominal investment flow for asset j is:

(4) $$i_{j,t} = P_{j,t} R_{j,t}$$

where $R_{j,t}$ is real investment.[2] Depending on the approach assumed – accelerator model, cash flow, user cost of capital – $R_{j,t}$ would be a function of real output for the aggregate economy (such as gross domestic product (GDP)) or for the industry level during period t, the difference in the relative inflation rates for the price of the investment asset compared to the total output (y) price, the interest rate, and other variables affecting investment, including tax relationships and parameters, cash flows, etc. This paper does not have a specific focus on the arguments or determination of the flow of investment; the framework could be easily augmented to include behavioral equations for investment in a richer specification, but the primary focus is to illustrate

[2] Note that equation (4) uses the convenience of expressing the price for current investment being the same as the price for the stock of assets; in practice, in the actual data, the price would vary depending on the composition of the stock and the investment flows.

how relative combinations of real and price changes combine to generate changes in the relative valuation of the residential asset stock.

Depreciation of asset j during period t is represented by[3]:

$$(5) \quad d_{j,t} = \delta_{j,t} K^*_{j,t}$$

where:

$\delta_{j,t}$ is the parameter for the "effective" depreciation rate for asset j during period t;

$K^*_{j,t}$ is the relevant level of the asset value/capital stock for determining the current period depreciation (in practice for the empirical purposes of this paper, defined as the average of the year-end levels for periods t-1 and t)[4].

The revaluation change for the nominal value of the stock of asset j during period t, $v_{j,t}$, is the residual valuation change once the investment and depreciation flows are accounted for relative to the prior period's end-of-period stock asset value. Because the BEA fixed asset valuations are "current cost" measures, the aggregate revaluation changes are closely related to the price index changes for the given investment asset:

$$(6) \quad v_{j,t} = \omega_{j,t} K^*_{j,t} \quad , \quad where\ \omega_{j,t} = \omega_{j,t}(\frac{P_{j,t}}{P_{j,t-1}}, z_{j,t})$$

and $z_{j,t}$ are other measurement and random factors beyond price changes affecting the revaluation of the stock of asset j from period t-1 to period t.

[3] Bureau of Economic Analysis (2003) states: "Depreciation is defined as the decline in the value of the stock of assets due to wear and tear, obsolescence, accidental damage, and aging. For most types of assets, BEA's estimates of depreciation are based on geometric depreciation patterns, which are supported by empirical studies of the prices of used equipment and structures in resale markets."

[4] Note this is roughly consistent with the approach described in BEA (2003): "New assets are assumed, on average, to be placed in service at midyear, so that depreciation on them in the first year is equal to one-half the new investment times the depreciation rate."

III. "Stylized Facts" and Capital-Output Ratios

Nearly 50 years ago, Nicholas Kaldor (1961) presented observed "stylized facts" or "broad tendencies" for the behavior of key macroeconomic variables for "capitalist societies" (also discussed by Romer (1989)) – including one of particular interest for this paper:

> "Steady capital-output ratios over long periods; at least there are no clear long-term trends, either rising or falling … This implies, or reflects, the near-identity in the percentage rates of growth of production and of the capital stock – i.e., that for the economy as a whole, and over longer periods, income and capital tend to grow at the same rate." (Kaldor, p. 178).

Such a characterization – if valid – can provide a useful basis for analyzing the behavior of relative asset valuations.

The capital-output ratio for asset j – expressed relative to total output in the economy, y_t – is:

$$(7) \quad \kappa_{j,t} = \frac{K_{j,t}}{y_t}$$

And the non-cyclical capital-output ratio is:

$$(8) \quad \bar{\kappa}_{j,t} = \frac{\bar{K}_{j,t}}{\bar{y}_t}$$

The Kaldor "stylized fact" for the constancy over time of the capital-output ratio was for "the economy as a whole". Here, the use of the total output measure in the denominator for specific asset groups allows for comparisons across the components as well as for the total.

The historical series for the capital-output ratio for total fixed assets, expressed as a percentage of potential gross domestic product (GDP) is shown in Chart 1. Chart 1 also shows the capital-output ratio for private and public fixed assets. Casual empiricism suggests that, although substantial short-run – and potentially cyclical – variation exists for the capital-output ratio for total (public and private combined) fixed assets, over the past six decades the total capital-output ratio has been relatively flat and has not exhibited a trend. That result would match the Kaldor "stylized facts" observation. Examination of the capital-output ratio for private fixed assets in Chart 1 – and looking at the pattern for the capital-output ratio for public government assets shown in Chart 2 – suggests a significant upward trend for private assets and a downward trend for public government assets.[5]

Table 1 shows ordinary least squares (OLS) estimates for equations for the post-World War II long-run trends (1947-2006) for the capital-output ratios for total, public, and private fixed assets, as well as for the trends for broad components of private assets, including for equipment and software, nonresidential structures, and residential structures. The OLS estimation was conducted in a system estimation assuring that the intercept and slope estimates for the components summed to the coefficient values for total fixed assets. The results shown in line 1 confirm the Kaldor stylized fact of no significant trend for the capital-output ratio for total fixed assets. However, a significant positive trend exists for the capital-output ratio for total private fixed assets, coinciding with the significant negative trend for the capital-output ratio for public fixed assets. For the broad components of private fixed assets, the estimates show significant positive trends for equipment and software and for residential structures. No significant trend is observed for nonresidential structures. The results show that, over time in the post-WWII period, for the broad relative allocation of capital in the economy there has been a substitution of investment and asset valuation out of Federal government (military) assets into private assets, notably equipment and software and residential assets.

[5] The long-run trend decline in the value of government assets relative to GDP is more than accounted for by the decline in Federal defense assets, while State and Local government assets – particularly for educational and general government buildings – increased relative to GDP.

Chart 1
Fixed Assets as Percent of Potential GDP

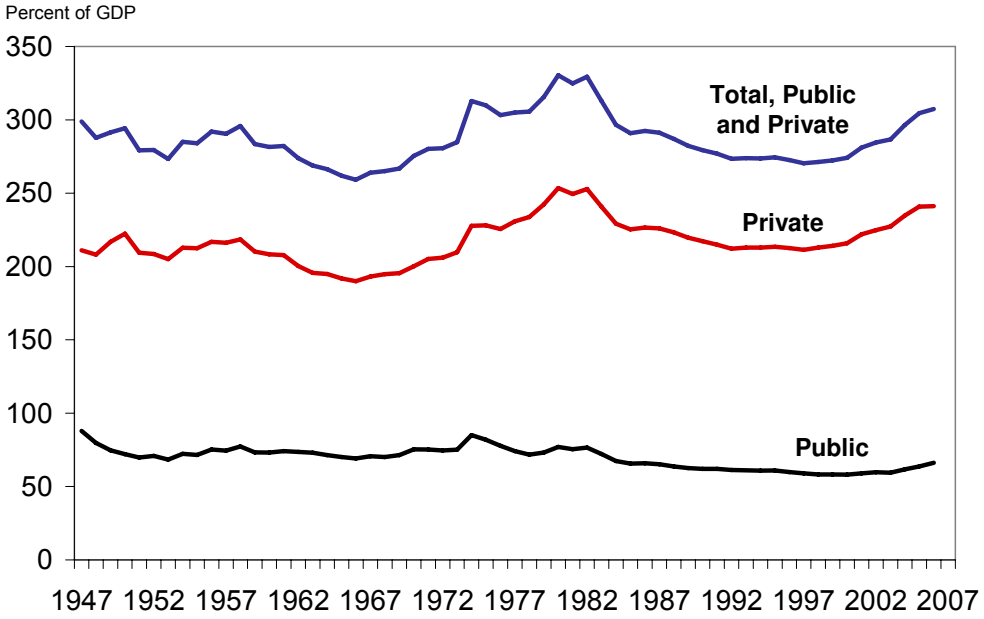


Chart 2
Public Fixed Assets as Percent of Potential GDP

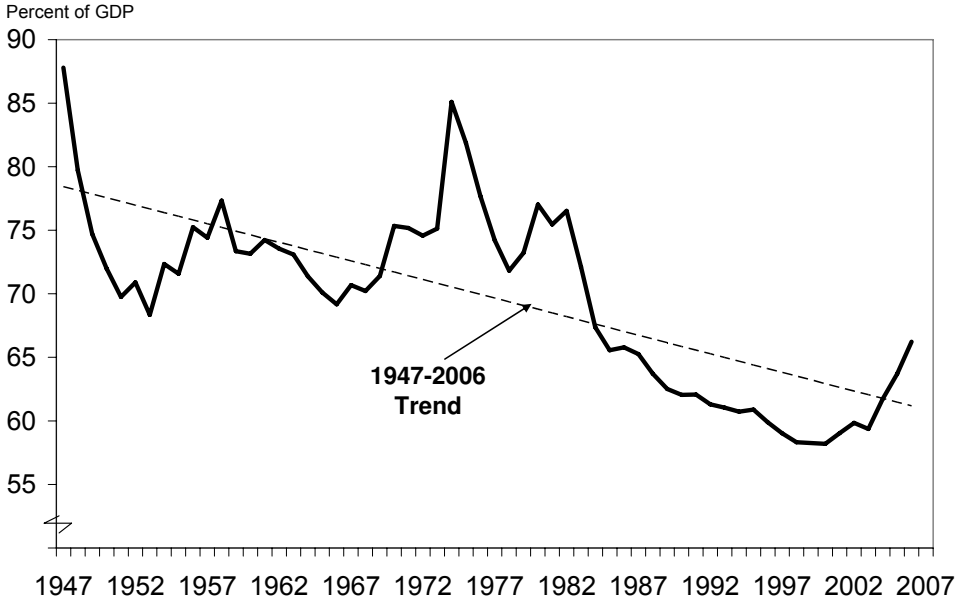


Table 1
Constrained Ordinarly Least Squares Estimates for Long-run Capital-Output Ratio Trends

$$\kappa_{j,t} = a_j + b_j\, t + e_j$$

Asset Measure	a_j	b_j
Total, Public and Private	284.60*	0.06
	(2.07)	(0.06)
Public	79.03*	-0.29*
	(2.07)	(0.06)
Private	205.57*	0.35*
	(2.07)	(0.06)
Equipment and Software	32.93*	0.20*
	(2.02)	(0.06)
NonResidential Structures	69.09*	0.00
	(2.02)	(0.06)
Residential	103.55*	0.15*
	(2.02)	(0.06)

* denotes significant at the 0.05 level.

Charts 3 through 6 show the capital-output ratios for total private fixed assets and by type of asset. For purposes of providing for comparisons across the charts and to the total for private fixed assets in Chart 3, the vertical axis has the same percentage point range (60 percentage points). The use of the restricted vertical axis also helps to illustrate the cyclical variation of the capital-output ratios around the longer-run trends and levels.

Charts 3 through 6 also include the estimated trends for the capital-output ratios and smoothed paths from using a Hodrick-Prescott (HP) filter with a smoothing parameter value of 250. In the absence of being able to determine a theoretically-based non-cyclical valuation for the capital-output ratio for the fixed asset components, one alternative is to use the HP-filter-based estimate for the non-cyclical value.[6] For analysis purposes, the trends and the HP estimates serve as valuations for the non-cyclical, equilibrium levels of the capital-output ratios.

[6] Consistent with the original discussion in Kaldor (1961), a theoretically-based valuation for the capital-output ratio to be used for comparison purposes wasn't identified, or one by type of assets. For example, efforts to identify a useful proxy using a user-cost or fundamentals approach (e.g., (Poterba (1984), Himmelberg, Mayer, and Sinai (2005)) did not yield useful results. Readers of this paper may be able to identify a theoretically-based estimate or

Chart 3
Capital to Potential GDP Ratio, Private Fixed Investment

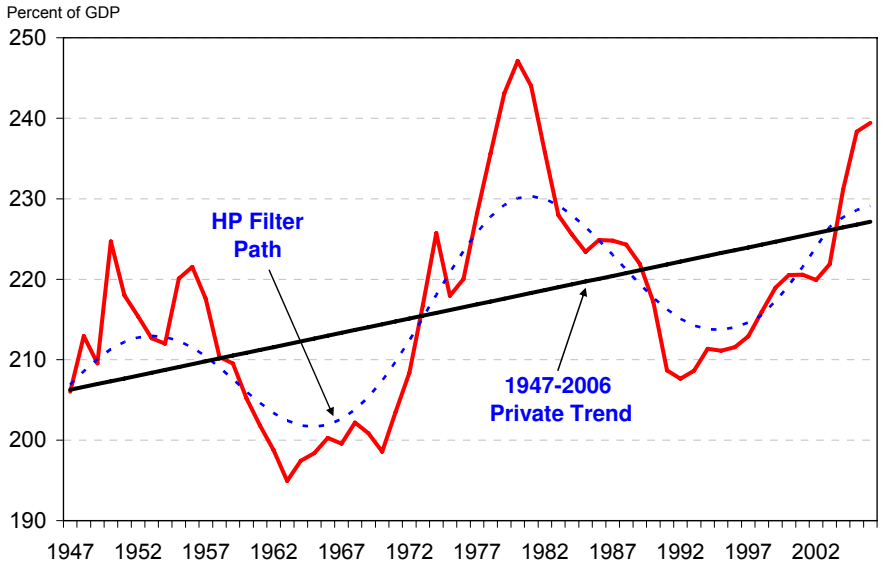


Chart 4
Capital to Potential GDP Ratio, Equipment and Software

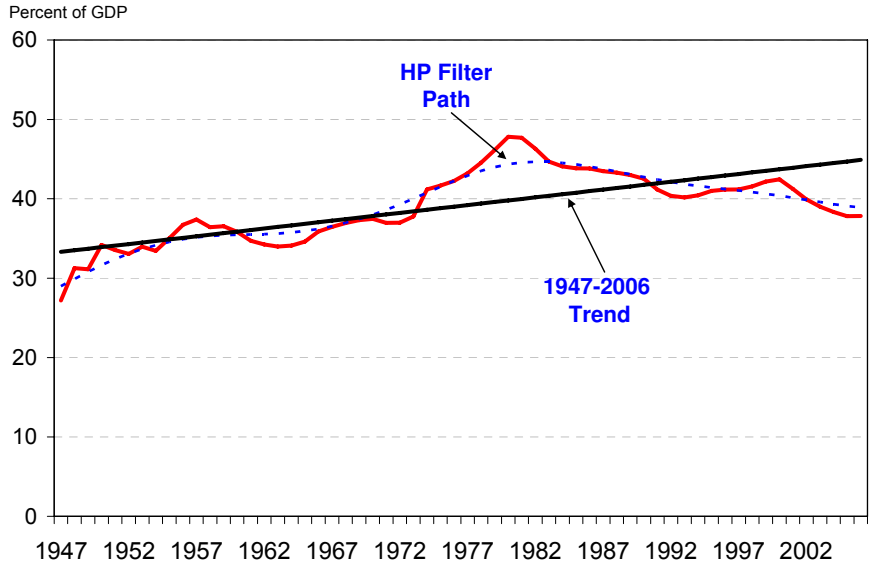


Chart 5
Capital to Potential GDP Ratio, NonRes Structures

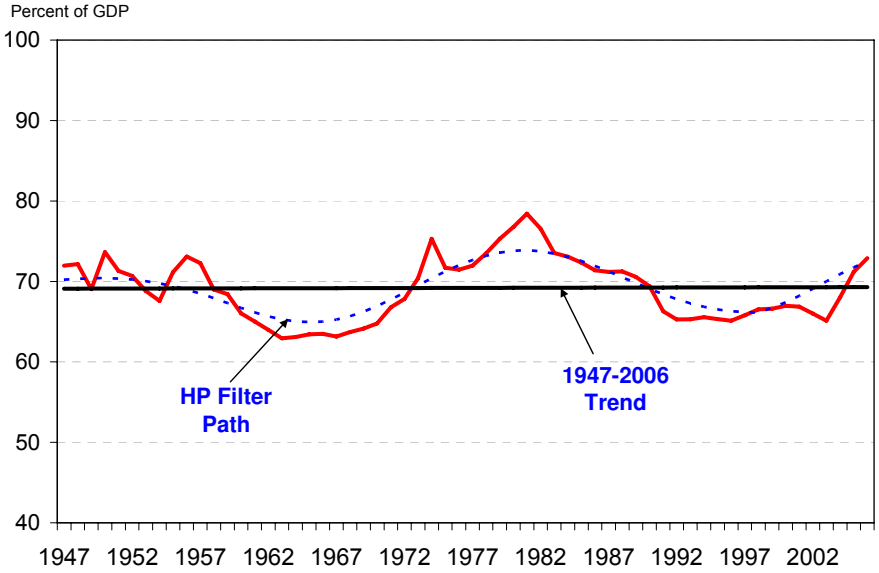
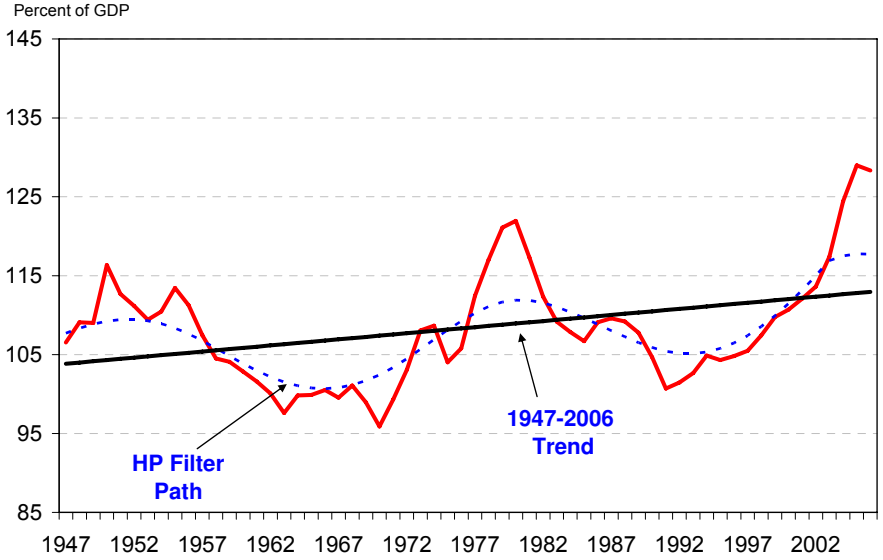


Chart 6
Capital to Potential GDP Ratio, Residential Structures



Charts 7 through 10 show the effective depreciation rates for the broad classes of private assets considered above – total private, equipment and software, nonresidential structures, and residential structures. The vertical axes for the charts show a spread of six percentage points to allow for visual comparison across the charts. Although the depreciation rates generally show little volatility or variation, some interesting observations emerge nonetheless. For equipment and software in Chart 8, the steady increase in the effective depreciation rate reveals the effects of an increasing share of investment occurring in shorter-lived assets coinciding with, for example, increases in investment in information technology. For residential structures in Chart 10 the effective depreciation rate from the data generally is about 1½ percent, with an obvious jump up to about 2.0 percent in 2005 from the destructive effects of Hurricanes Katrina, Rita, and Wilma that year. (Smaller hurricane-induced increases also occurred in 1992 and 2004.) Analogously, the depreciation rate for nonresidential structures in Chart 9 typically is about 2¾ percent, but shows higher values during years when earthquakes and hurricanes damaged business structures, as well as a higher value also being observed in 2001 resulting from the September 11 terrorist attacks. The effective depreciation rate for total private assets shown in Chart 7 reflects the changes within asset groups as well as changes in the relative composition across assets. Hence, the general upward trend in the effective depreciation rate for total private assets across the historical period and into the early 2000s reflects the relatively flat depreciation rates for structures and the rising rate for equipment and software as well as the relative balance of investment gains and valuations across the assets. However, from 2001 to 2006, the effective depreciation rate for total private assets declined significantly, reflecting the sharp increases in investment in residential structures and the rising nominal value of those assets. Hence, the effective depreciation rate for the nominal assets declined as a greater portion of the nominal value of total stock was in low-depreciation residential assets.

IV. Asset Valuation Overhang and Possible Resolution Scenarios for Residential Assets

The capital stock overhang percentage for asset j in period t is given by:

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an improved empirically-based one to use for the non-cyclical valuation on a basis consistent with the capital-output ratio approach of this paper.

Chart 7
Effective Depreciation Rate -- Total Private

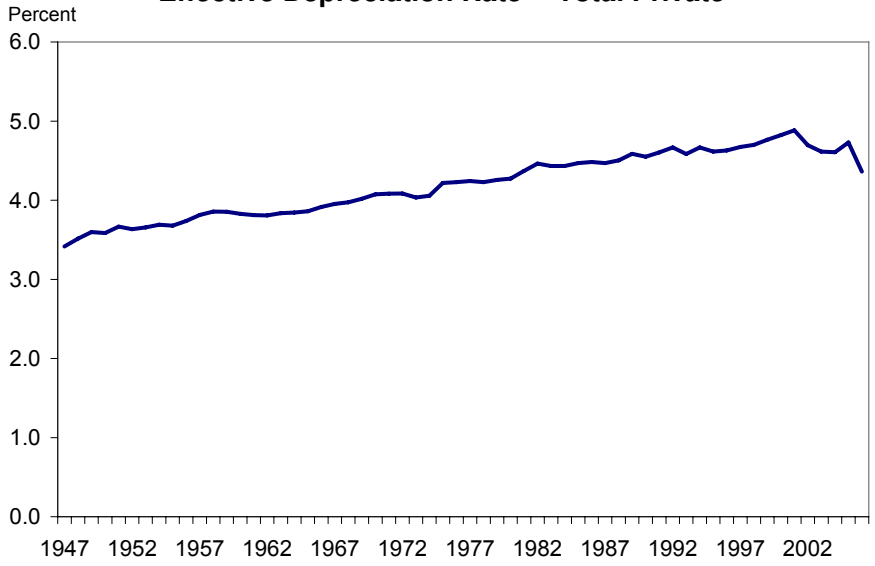


Chart 8
Effective Depreciation Rate -- Equipment & Software

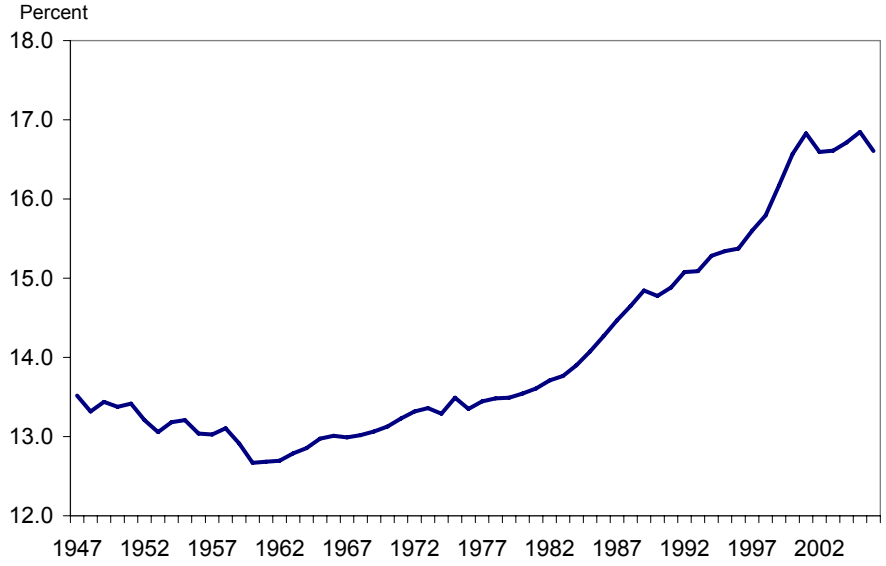


Chart 9
Effective Depreciation Rate -- NonRes Structures

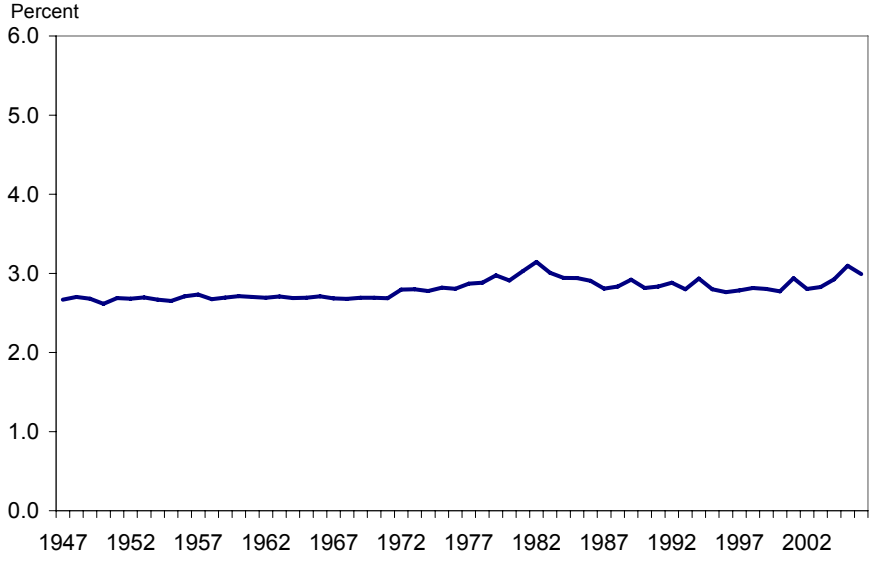
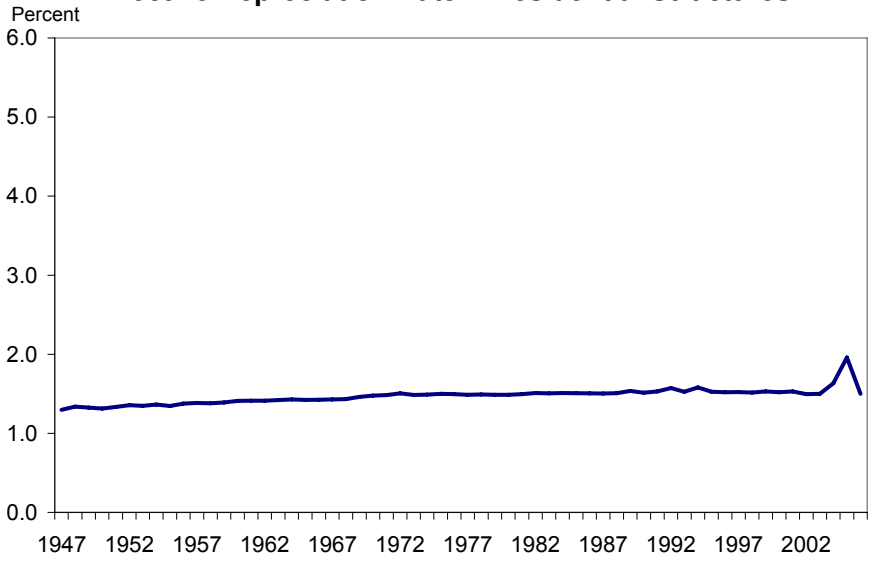


Chart 10
Effective Depreciation Rate -- Residential Structures



$$(9) \quad O_{j,t} = \frac{K_{j,t} - \overline{K}_{j,t}}{\overline{K}_{j,t}}$$

Table 2 shows the overhang percentages for residential assets of recent years – in 2005, 2006 and the approximate value for 2007 – along with alternative illustrative scenarios for resolution of the overhang over one- and two-year periods. The scenarios are shown for two alternative overhang estimates – based on the HP non-cyclical valuation and the long-run trend valuation.[7] Also, for purposes of illustrating the relationships between real residential investment, prices and the relative valuation of residential assets – and the extent of correction required under constraints – the scenarios alternatively use restrictive assumptions for keeping real residential investment fixed or the residential investment price index fixed. Hence, the scenarios provide answers to questions like: "How far would the residential investment price have to fall over a given period of time to eliminate the overvaluation if all of the burden of adjustment was on prices and not on the real residential investment flows?" Or alternatively, "If prices were constrained and not allowed to decline, how much would real residential investment have to decline over a given period of time to eliminate the overvaluation?"

The cases for Scenarios I and II show the adjustments needed to eliminate the overhang relative to the HP noncyclical levels; Scenario I for the correction by 2008 and Scenario II for correction by 2009 (see Chart 11). The results in line 1 show that if prices do not adjust it is not possible to eliminate the full overhang by the end of 2008 even if real residential investment were to fall to zero; an overhang of 2.4 percent would still remain.[8] The results of line 2 show that if the overhang were completely eliminated by only a price adjustment and no further decline in real residential investment, the NIPA residential price index would have to decline by 5.8 percent to eliminate the overhang based on the HP non-cyclical level. The cases for Scenario II in lines 3 and 4 illustrate the adjustments needed to eliminate the overhang relative to the HP

[7] For purposes of making projections of the residential asset relative valuation, an effective depreciation rate of 1½ percent is assumed for residential structures and the revaluation change is derived from the change in the assumed NIPA residential investment price and the observed historical relationship between that price measure and the observed effective valuation change.

[8] The extreme case of a correction by a "forced" increase in depreciation (i.e. "bulldozing the capital stock") isn't considered here.

Table 2

Corrections Required for Elimination of Residential Overhang Under Alternative Scenarios

	2005 Overhang Percentage	2006 Overhang Percentage	Approximate 2007 Real Fixed Residential Investment	Approximate 2007 NIPA Residential Price Index	Approximate 2007 Overhang Percentage	2008 for Assumed Path Real Fixed Residential Investment	2008 for Assumed Path NIPA Residential Price Index	2008 for Assumed Path Overhang Percentage	2009 for Assumed Path Real Fixed Residential Investment	2009 for Assumed Path NIPA Residential Price Index	2009 for Assumed Path Overhang Percentage
Relative to Estimated HP Non-Cyclical Level											
I. Correction by 2008											
1. Real Adjustment Only	11.8	11.0	473	135.5	8.9	0	***135.4***	2.4*	--	--	--
Note: % decline:						-100.0					
2. Price Adjustment Only	11.8	11.0	473	135.5	8.9	***433***	127.6	0	--	--	--
Note: % decline:							-5.8				
II. Correction by 2009											
3. Real Adjustment Only	11.8	11.0	473	135.5	8.9	225	***135.4***	4.5	166	***135.4***	0
Note: % decline:						-52.4			-64.9		
4. Price Adjustment Only	11.8	11.0	473	135.5	8.9	***433***	133.1	4.5	***433***	130.2	0
Note: % decline:							-1.8			-3.9	
Relative to Historical Average Level											
III. Correction by 2008											
5. Real Adjustment Only	16.8	15.7	473	135.5	13.2	*0*	***135.4***	6.0*	--	--	--
Note: % decline:						-100.0					
6. Price Adjustment Only	16.8	15.7	473	135.5	13.2	***433***	122.9	0	--	--	--
Note: % decline:							-9.3				
IV. Correction by 2009											
7. Real Adjustment Only	16.8	15.7	473	135.5	13.2	70	***135.4***	6.6	8	***135.4***	0
Note: % decline:						-85.2			-98.3		
8. Price Adjustment Only	16.8	15.7	473	135.5	13.2	***433***	131.3	6.6	***433***	126.8	0
Note: % decline:							-3.1			-6.4	

Notes: Bold italicized numbers are assumed fixed values for the scenario.
* denotes an incomplete adjustment in the overhang percentage for the scenario.

Chart 11

Capital to Potential GDP Ratio for Residential Structures

Alternative Scenarios to Eliminate Overvaluation

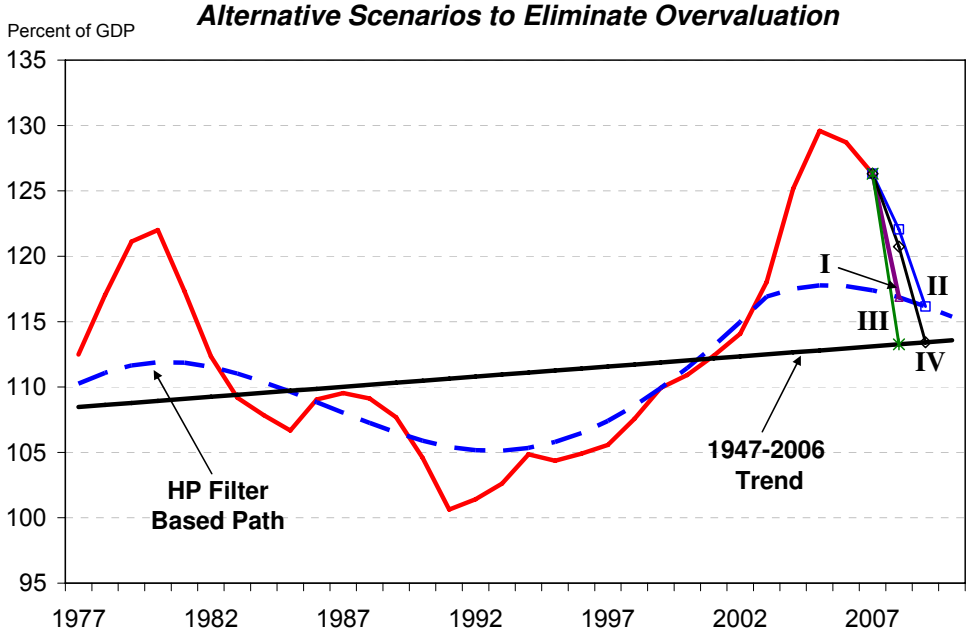
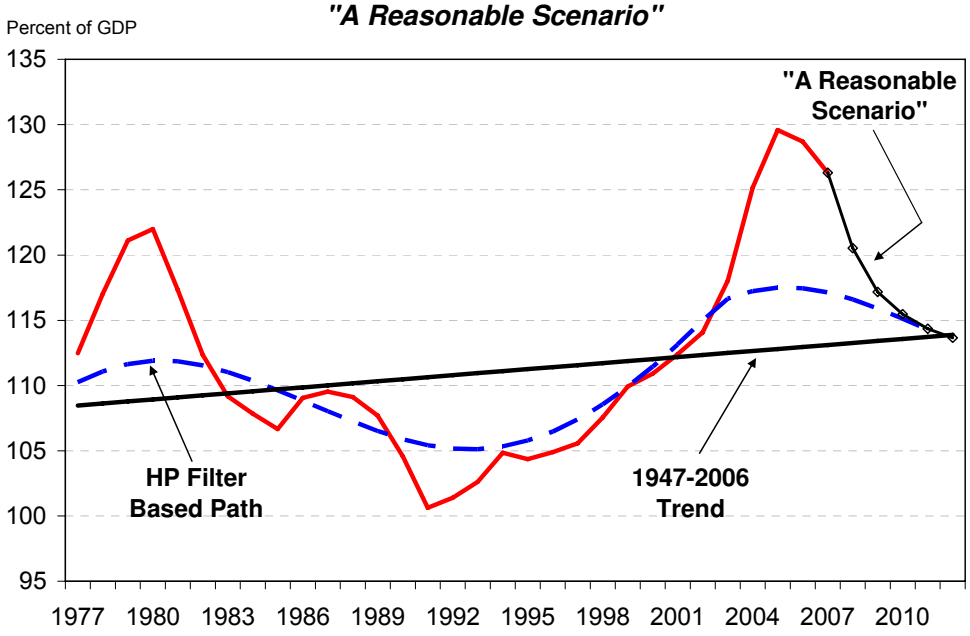


Chart 12

Capital to Potential GDP Ratio for Residential Structures

"A Reasonable Scenario"



non-cyclical level by the end of 2009. With real investment adjustment only and no price change, line 3 shows that a linear path to correct the imbalance would require a decline in real residential investment of 52 percent in 2008 and an additional decline – to a 65 percent decline overall from 2007 – to eliminate the overhang in 2009. If the adjustment occurred only through price changes, the decline in prices would be -1.8 percent for 2008 and -3.9 percent by 2009. The reasons for the relatively small price adjustments are that 1) the decline is spread over 2 years, allowing for the increase in overall prices to continue to rise and contribute to the decline in relative prices; 2) depreciation helps to eliminate about 2½ percent of the overvaluation over the 2 year period; 3) the NIPA residential price index (which is for structures but not land) is a less-responsive price measure than some other housing price indexes, which would tend to show larger declines for that NIPA measure change; and 4) the HP filter value is above the long-run fixed trend level.

The cases for Scenarios III and IV show the adjustments needed to eliminate the overhang relative to the long-run fixed trend levels by 2008 (Scenario III) and by 2009 (Scenario IV). The results in line 5 show that, as in Scenario I, if prices do not adjust it is not possible to eliminate the full overhang by the end of 2008 even if real residential investment were to fall to zero; an overhang of 6 percent would still remain. The results of line 6 show that if the overhang were completely eliminated by only a price adjustment and no further decline in real residential investment, the NIPA residential price index would have to decline by 9.3 percent to eliminate the overhang based on the long-run trend level by the end of 2008. The cases for Scenario IV illustrate the adjustments needed to eliminate the overhang relative to the long-run trend level by the end of 2009. With real investment adjustment only and no price change, line 7 shows that a linear path to correct the imbalance would require a decline in real residential investment of 85 percent in 2008 and an additional decline to an 98 percent decline overall from 2007 to eliminate the overhang. If the adjustment occurred only through price changes, the decline in prices would be -3.1 percent for 2008 and -6.4 percent by 2009.

Scenarios I – IV provide illustrative results under different restrictive assumptions. The question remains: What would be a reasonable scenario for the combined set of adjustments for real residential investment and prices to resolve the imbalance? Historical patterns may provide

useful information. The time series behavior of the detrended series for the relative valuation for residential assets was examined; specifically, the differences of the residential asset value relative to potential GDP from (1) the HP filter value; and (2) the fixed trend value. Identification of the series indicated they were well represented by moving average specifications, with the HP difference being an MA(3) and the fixed trend difference being an MA(4). Based on the resulting projected patterns from those series, a "reasonable scenario" for the path for the correction of the overvaluation of residential assets is shown in Chart 12. The pattern shows the correction to the HP non-cyclical level largely occurring over two to three years and subsequent change in the relative valuation along the HP path and close to the long-run trend. No assumption is made here about behavior beyond the general period of correction.

As in the discussion above for Table 2, the relative contributions of real and price changes in such a scenario remain at issue. To better understand how real and price changes have contributed historically to changes in the relative valuation through the capital output ratio measures, consider the following expanded expression from equations (2) and (7):

$$(10) \quad \kappa_{j,t} = \frac{K_{j,t}}{y_{j,t}} = \frac{P_{j,t} X_{j,t}}{P_{q,t} q_t}$$

where $P_{q,t}$ is the price level for total output and q_t is real total output. Totally differentiating the right-hand expression and rearranging terms yields:

$$(11) \quad \frac{d\kappa_{j,t}}{\kappa_{j,t}} = \left[\left(\frac{dP_{j,t}}{P_{j,t}} - \frac{dP_{q,t}}{P_{q,t}} \right) + \left(\frac{dX_{j,t}}{X_{j,t}} - \frac{dq_t}{q_t} \right) \right]$$

Equation (11) shows that changes in the capital-output ratio are comprised of changes in the relative prices of investment and changes in the real capital stock relative to the change in real total output (real GDP in the comparisons used). Note that the changes for the real capital stock has two components (not shown): the change in real investment relative to the asset stock minus the depreciation flow relative to the asset stock (the depreciation rate). The historical series for the contributions of relative real and price changes to the total change are shown in Chart 13.

Chart 13

Contributions to Change in Residential Capital-GDP Ratio

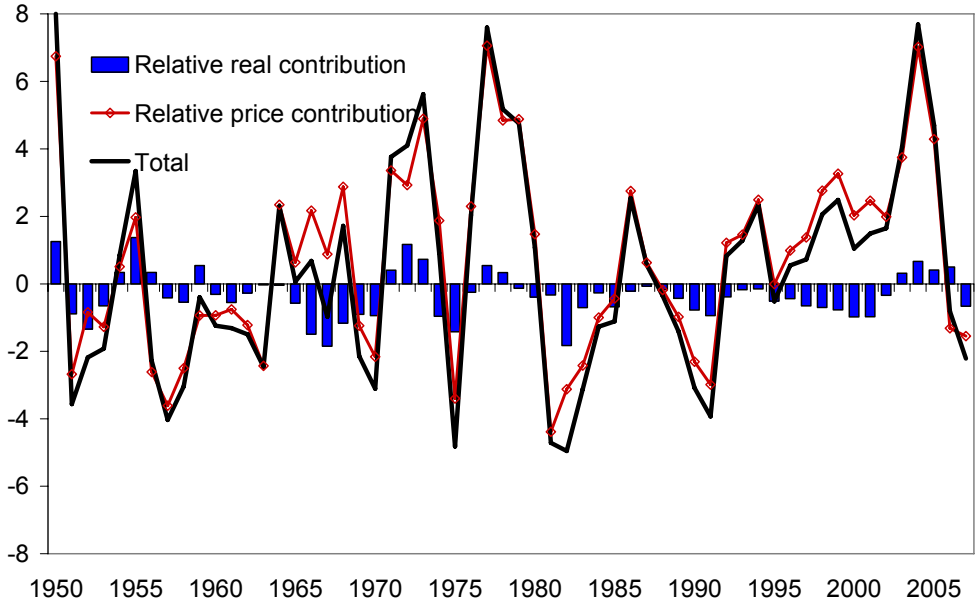
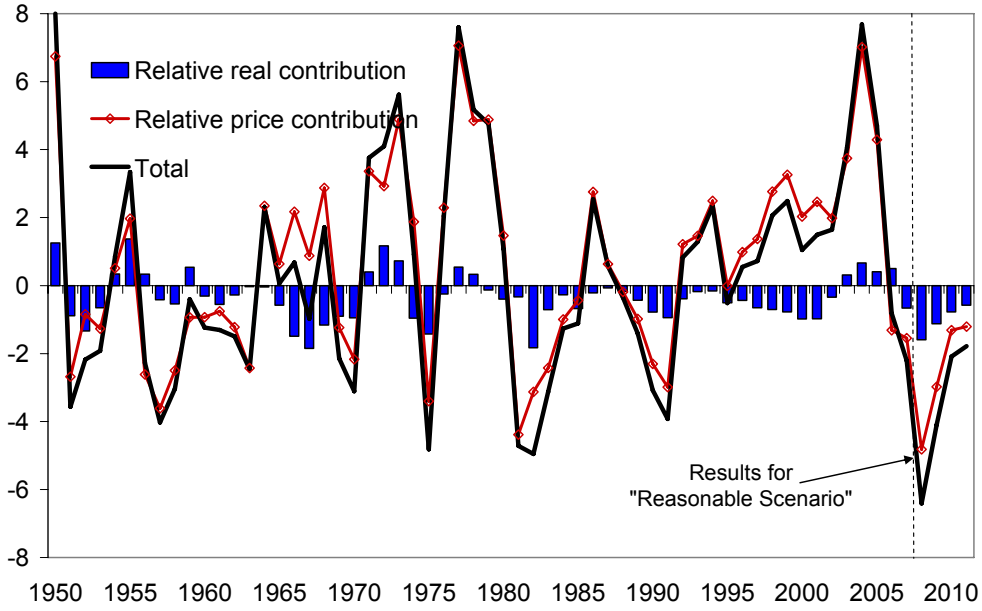


Chart 14

Contributions to Change in Residential Capital-GDP Ratio



Historically, the relative contributions of real and price changes have shown a much larger price effect than a real effect. Because of the large size of the capital stock relative to investment flows, and as illustrated in the scenarios of Table 2, generally it is "difficult" for changes in real investment to generate substantial adjustment in the value of the asset stock. Over the 1950-55 "correction" period, for example, the price change ultimately accounted for over 90 percent of the total adjustment of the valuation; for the 1980-85 period, the price change ultimately accounted for about three-quarters of the adjustment. Under a roughly similar assumed pattern – with three-quarters of the adjustment over a five-year period (2006-2011) resulting from price adjustment, the resulting paths for the price and real investment flows for residential investment are shown in Table 3 and the resulting relative contributions are shown in Chart 14. The results shown should not be interpreted as a forecast; rather, they are illustrative of the rough patterns and magnitudes of adjustment – combined real and price – that would occur in a correction of the overvaluation.[9] Even though the correction to the relative overvaluation would be ongoing over the period shown, the absolute levels of real investment and the NIPA price index would bottom out and begin to rise – for the scenario shown, real investment bottoms out in 2008 and grows thereafter and the price index bottoms out in 2009 and increases thereafter. The correction is able to continue to occur within that pattern because of the effects of depreciation and the ongoing decline in the relative residential price – the rate of change in the residential investment price being less than the rate of change in the overall economy price level.[10]

Table 3
Real Residential Investment and NIPA Residential Price Index for "Reasonable Scenario"

	2006	2007	2008	2009	2010	2011
Real Residential Investment $Bils	570	473	383	436	477	500
NIPA Residential Investment Price	134.3	135.5	132.7	132.0	132.9	134.3

[9] A potential area for additional research – and an area in which a successful effort was not yet attained for the purposes of this paper – would be to use a more rigorous approach for identifying projected combinations of prices and real residential investment; for example, using a simultaneous equation approach with behavioral equations for real and price variables and with the lagged overhang values included as explanatory variables.
[10] Note that this assumed pattern for real investment is similar to that of private forecasters at this time. For example, the February 2008 Blue Chip consensus forecast showed housing starts bottoming out at 1.02 million in 2008 and then increasing to 1.17 million in 2009.

The NIPA residential investment price is just one of many alternative measures of housing prices. It is important to recognize that the NIPA measure is a broad housing investment measure as it also includes multifamily structures and improvements, but it is also more limited in that it does not include the value of land. Consider a comparison to a well-recognized alternative series for single-family housing – the Case-Shiller national price index.[11] Chart 15 shows the patterns for the annual percentage changes in the NIPA price index and the Case-Shiller national price index with the projection values for Case-Shiller based on the estimated historical relationship with the NIPA price series. The higher volatility of the Case-Shiller index price change is clear from the chart.[12] The overall decline in the derived level estimates of the Case-Shiller series for this scenario from 2006 to 2010 is 14 percent.[13] Through the third quarter of 2007, a decline of just over 4 percent from the 2006 annual average had already occurred (i.e., about one-fourth of the estimated total adjustment).

VI. Summary and Closing Points

The analysis and information presented here should be viewed as rough approximations of the relative magnitudes of overvaluation and the correction paths required; the scenarios presented are not forecasts. Also, the data and the methodology employed do not lend themselves to precision. Even so, the relative levels of asset valuation in comparison to approximate long-run and trend levels for capital-output ratios provide a rough benchmark for understanding the extent of overvaluation for residential assets and the magnitudes of the adjustments required.

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[11] The Case-Shiller index uses the "repeat sales pricing technique" developed by Karl Case and Robert Shiller using data on single-family home re-sales.

[12] Davis and Heathcote (2006) describe the greater volatility of land prices compared to residential structures with a set of results that "suggests that fluctuations in house prices are primarily attributable to fluctuations in land prices rather than fluctuations in structures prices."

[13] As with any result from an estimated relationship, one must be careful in interpreting the result and the weight placed on it. The regression estimate for the relationship for the period 1988-2006 is (standard errors in parentheses):

```
Case-Shiller price % change = -2.47 + 2.33 NIPA price % change
                              (1.62)  (0.41)          R-squared = 0.651
```

Note that these results are consistent with the observation of Davis and Heathcote of the greater volatility of land prices relative to structures.

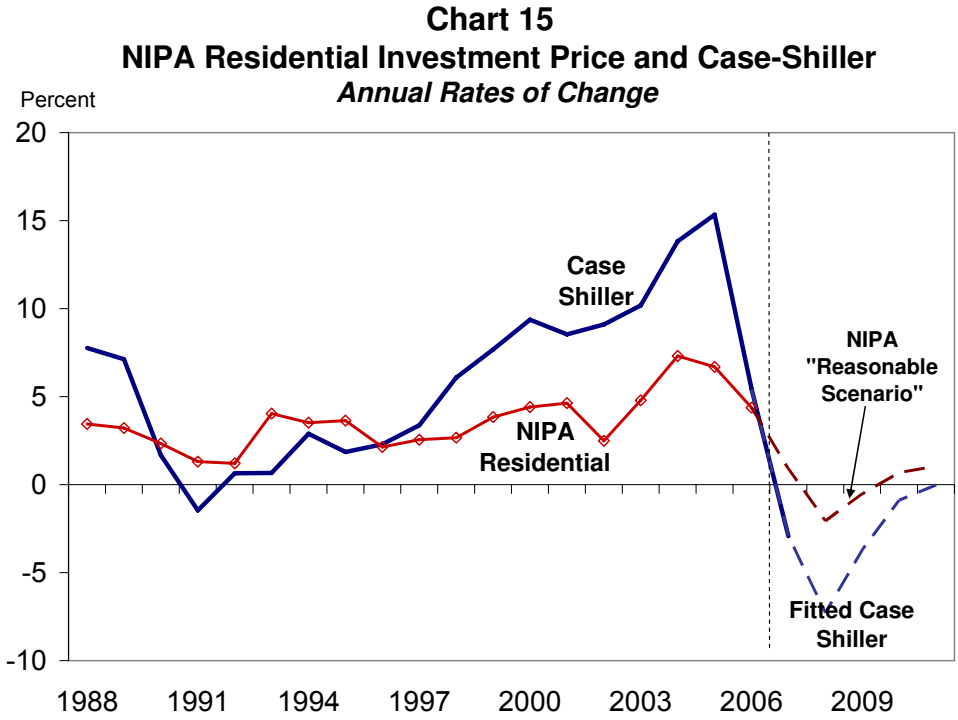
Chart 15
NIPA Residential Investment Price and Case-Shiller
Annual Rates of Change
Percent
20
15
10
5
0
-5
-10
1988
1991
1994
1997
2000
2003
2006
2009
Case Shiller
NIPA Residential
NIPA "Reasonable Scenario"
Fitted Case Shiller

The key observations are:

1. Relative valuations from the BEA data indicate a substantial overvaluation of residential assets in recent years. By the end of 2007 the correction for the overvaluation of residential structures was well underway with the peak overvaluation that occurred in 2005 having been reduced by roughly one-fourth.

2. Additional needed changes in the overall valuation of the housing stock would be more readily accomplished through price changes than through further declines in real residential investment. In fact, the faster the price changes occur, the more readily the overvaluation would be eliminated and a lower portion of the burden of adjustment would be on real residential investment. In the absence of price changes, overvaluation of the residential asset stock would persist and put downward pressure on real residential investment to correct the overvaluation.

3. A reasonable scenario that not only accounts for current relationships but also reflects prior historical patterns of adjustment suggests that the needed further adjustment in residential asset markets could largely occur over the 2008-2009 period. Under that scenario, the bulk of the correction in *real* residential investment is behind us, and real investment would bottom out in 2008 and begin to recover in 2009. Relative to the effect on the change in valuation of the asset stock, real residential investment could begin to grow again even as the correction in the valuation of the stock continued – not only because of the price effects but also because on the real side the effect of depreciation is a significant negative effect on the overall real contribution. The reasonable scenario indicates that prices of residential assets, however, would continue to decline into 2009, and significant increases would not be expected to occur for a number of years. Ultimately, what matters is the performance of *relative* residential asset prices; given the relatively low inflation rate in the overall economy, prices could begin to increase but likely, at best, at relatively low rates of increase.

4. The broad relationships across different asset groups suggest that the large increases in the investment flows and valuation for residential assets this decade coincided with valuations for other assets that generally are not excessive. This contrasts with the severe general

overvaluation across investment assets that occurred in the late 1970s-early 1980s experience, for example. In fact, the data relationships suggest that, relative to long-run trends, an "undervaluation" of business equipment and software assets currently exists. A reasonable outlook at this time, therefore, is for a reallocation of investment and valuation from the correction in residential assets into business equipment and software. Higher real investment and/or higher prices for equipment and software would be required to restore a higher valuation of the stock of those assets relative to GDP – that is to raise the capital-output ratio for equipment and software.

5. The discussion and relationships presented are for national averages; changes in specific geographic locations and markets could be much different than those at the national level. The magnitude of the changes in specific markets and areas would be affected to the extent pressures for adjustment are concentrated in geographic areas or regions.

6. The price changes described in the scenarios presented are on a NIPA residential investment price basis – a measure that is less volatile than other housing price measures, notably the Case-Shiller index. In the "reasonable scenario" case that showed an overall decline of less than 3 percent on a NIPA basis, that would coincide with an estimated decline of about 14 percent for the Case-Shiller index (based on historical relationships between the series).

Generally, the analysis and discussion presented in this paper provide an alternative methodology – a "different approach" – for considering the relative valuation of fixed assets, and how relative valuations tend to adjust over time based on long-run relationships. Although the scenarios presented in this paper shouldn't be viewed as describing specific forecasts or expected outcomes, they can provide a potentially useful benchmark – albeit a rough one – against which alternative projections or subsequent outcomes can be compared.

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