THE DECLINE IN HOUSEHOLD SAVING AND THE WEALTH EFFECT

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Abstract—Using a unique set of household-level panel data, we estimate the effect of capital gains on saving by asset type, controlling for observable and unobservable household-specific fixed effects. The results suggest that the decline in the personal saving rate since 1984 is largely due to the significant capital gains in corporate equities experienced over this period. Over 5-year periods, the effect of capital gains in corporate equities on saving is substantially larger than the effect of capital gains in housing or other assets. Failure to differentiate wealth effects across asset types results in a significant understatement of their size.

I. Introduction

According to national income accounts, personal saving in the United States was 1.7% of disposable income in 2001—its lowest level since 1934. This low follows a 17-year fall from a value of 10.8% in 1984. The decline is particularly striking in that the saving rate averaged a relatively stable 7% to 10% from the end of World War II up to 1984. Despite the fall in personal saving, household balance sheets have actually improved over the past two decades, owing largely to sizable capital gains, primarily in corporate equities.

In this paper, we estimate how much of the decline in the personal saving rate can be explained by the capital gains households received during the stock market boom of the 1980s and 1990s, when real equity prices quadrupled. In contrast to previous studies, we use a unique set of household-level panel data that provide measures of household saving and capital gains. Our results indicate that most of the decline in the personal saving rate over the 1990s can be explained by the unprecedented rise in the value of corporate equities. Moreover, we provide robust evidence that the spending response to capital gains in corporate equities is larger than to capital gains in other assets, including housing. Estimating a single wealth effect from a combination of assets masks significant heterogeneity across asset type. In particular, our estimates suggest that a one-dollar capital gain in corporate equities increases spending in a 5-year interval by as much as 19 cents.1

The rest of the paper is organized as follows. The next section describes the data source and the way we construct the main saving concepts of interest from this data. Section III summarizes the results obtained from our empirical models of the relationship between household saving and capital gains across several assets. Section IV examines the extent to which our estimates of the wealth effects can account for the decline in personal saving over the past two decades. The final section provides our conclusions.

II. Definitions of Wealth and Saving

The measures of household saving and capital gains used in this paper are derived from the Panel Study of Income Dynamics (PSID). The PSID has gathered almost 30 years of extensive economic and demographic data on a nationally representative sample of approximately 5,000 (original) families and 35,000 individuals living in those families. We use the PSID wealth modules included in the 1984, 1989, and 1994 surveys to examine the evolution of household wealth and saving over the 10-year period. These modules measure net equity in homes and nonhousing assets divided into seven categories. The modules also include questions about new purchases and sales of individual assets, so that, in principle, active and passive (capital gains) saving can be distinguished.

Total household wealth in the PSID comprises eight components: main home equity (w1); real estate other than home equity (w2); a farm or private business (w3); automobiles, motor homes, or boats (w4); checking and saving accounts, money market funds, certificates of deposit, government saving bonds, and treasury bills, including those in investment retirement accounts (w5); equities in publicly traded corporations, mutual funds, investment trusts, and investment retirement accounts (w6); other savings, which include corporate bonds, rights in a trust or estate, the cash value of life insurance, and valuable collections (w7); and total noncollateralized debt, which is negative (w8). The first four components comprise real assets, and the last four comprise financial assets.2

The total net wealth in each of the 1984, 1989, and 1994 waves of the PSID is simply \( W_t = \sum_{i=1}^{8} w_{it}, \) where \( t = 1984, 1989, \) or 1994. In 1989 and 1994, respondents were also asked about their active saving over the previous 5 years, defined as the net purchase of assets. These questions were specific to components of wealth where capital gains are most relevant, including net investment in real estate other than the main

spending response to housing gains. Englehardt (1995) reports a reduction in saving of roughly 14 cents per dollar of housing gain when the sample is restricted to nonmovers. Skinner (1989) finds that, after controlling for fixed effects, capital gains in housing have little effect on saving. This is consistent with the results reported in this paper. See Poterba (2000) for an excellent survey of this literature.

1 All dollar values are converted to 1996 dollars using the chain price GDP deflator for personal consumption.

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1 Past studies quantifying the wealth effect have yielded a range of results. Macroeconomic models of household consumption in the United States imply that an extra dollar of wealth increases spending by 2 to 5 cents. Relatively few studies have examined the wealth effect by asset type. Using aggregate data, Peek (1983) found a larger spending response to gains in net financial assets than to gains from owner-occupied housing. Peek’s estimated response to capital gains in equities is large and in line with those reported in this paper. Other studies have used household-level data to focus solely on the effect of housing wealth, with varying results. Whereas Hoynes and McFadden (1994) report a small positive

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and would incorrectly be treated as a capital gain. Because the form of an inheritance or gift is unknown, it is not possible to distinguish an inheritance of stocks from a capital gain in stocks. However, questions were asked in the 1989 and 1994 PSID wealth modules about the value of inheritances received and the net transfers due to gifts from family or friends and changes in family composition. These values are used as controls in our modeling.

The liquidation of a pension can also cause the survey measure of wealth to change. Because defined-contribution pensions are not included in the PSID’s measure of wealth, a household that liquidates a pension will incorrectly show an increase in wealth as the resources get channeled to the assets that are measured, albeit reduced by any amount consumed. As with inheritances, the value of the assets removed from pension accounts was reported in the 1989 and 1994 survey. Our modeling of household saving below also controls for this type of transfer.

Finally, defining these saving concepts with panel data requires a precise definition of the household. Households are defined as families in which the head of household did not change over the period 1984 to 1994. Of the 6,915 households in the 1984 survey, there were 4,127 with the same head over the following 10 years. This does not restrict the sample to households with no changes in family composition (such as divorce), but means only that the head remains the same over all years. Because getting married or separated can have a large impact on the balance sheet if for no other reason than the combining or dividing of two people’s assets, changes in marital status are taken into account in our analysis below.

Table 1 suggests a possible relationship between household active saving and capital gains in stocks by arraying these values across age and education groups. On average, capital gains in stocks were clearly larger, and active saving was lower, between 1989 and 1994 than between 1984 and 1989. Capital gains were concentrated among households whose head was 45 to 64 years old, in part because they had a longer time to accumulate stocks by 1984 and typically

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3 Self-reported savings over the two 5-year periods are converted to 1996 dollars by using the 5-year average of the chain price GDP deflator for personal consumption.

4 The PSID has questions on homeownership, house value, and the outstanding mortgage in each year of the survey.

5 The initial equity for those that moved from renting to owning is set to 0.
hold a larger share of equity in their portfolio than other age groups. But these are the same age groups that experienced the largest across-period drop in active saving. With regard to education, by far the largest increase in capital gains was among college graduates, who simultaneously reduced their active saving by 20%.

Because both older and more highly educated households also have more income, the last two columns of Table 1 present mean saving rates across the two 5-year periods, defined as the ratio of mean active saving to mean total family income. Though there was a slight increase in the saving rate among those households whose head was aged 25 to 44, the saving rate of households aged 55 to 64 fell by 4 percentage points between the two periods. Similarly, the largest fall in the saving rate is observed among college-educated households, where the rate dropped from 14.3% to 10.8%. Across both education and age, the largest decline in saving rates occurred where capital gains were the largest.

The PSID data cover a period of sizable capital gains in corporate equities. One implication of the wealth effect is that households that owned stocks at the beginning of the sample period should also be those with the largest reduction in saving. Table 2 reports the mean and median of household total active saving over the periods 1984 to 1989 and 1989 to 1994, stratified by whether or not stocks were owned in 1984. Total active saving rates are shown in the last two columns. Not surprisingly, both the level and rate of total active saving are higher among stockholders, which demonstrates the necessity of fixed-effects analysis. However, whether measured in levels or as a fraction of income, the decline in saving between the two five-year periods is much larger among stockholders. For example, the decline in the mean (median) total saving rate of nonstockholders was 0.1 (0.4) percentage point, while the decline in the mean (median) total saving rate among stockholders was 4.6 (3.5) percentage points. The concentration of the saving decline among those participating in the stock market in 1984 and therefore with exposure to capital gains over the entire ten-year period indicates that the stock market run-up may have played a significant role.

### III. Empirical Model of Household Saving

The results in Tables 1 and 2 are suggestive of an effect of capital gains on active saving, but multivariate modeling is necessary to isolate the relationship. The basic model we consider projects active saving onto capital gains, income, and selected demographics. The variables of interest are observed twice for each household: once for the period 1984 to 1989 and once for the period 1989 to 1994. Income is measured as the sum of total family income over each 5-year period.

Before reporting the results, two key statistical issues must first be addressed. First, considerable heterogeneity exists in saving behavior among what appear to be observationally equivalent households (Venti & Wise, 1999). Even among households with similar lifetime income paths, some are savers and others are not. Heterogeneity implies a strong positive association across households between saving and capital gains. Households that are active savers every year will have accumulated considerable wealth, thus increasing their exposure to the possibility of capital gains and losses. The panel aspect of the data is used to eliminate such household fixed effects by examining how within-household changes in active saving respond to within-household changes in capital gains. Although fixed-effect estimates eliminate the effect of demographic characteristics such as education, race, and gender, we include demographic measures of age as well as indicators of transitions into and out of marriage.

A second issue stems from measurement error. Household wealth is measured with error and the same is certainly true for active saving. Measurement error has two effects on

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Note: Sample consists of PSID households whose head was the same in 1984, 1989, and 1994. The top and bottom 1% of total active and passive saving were dropped (3,969 observations). 1984 sample weights used in all calculations. Saving rate is defined as the ratio of mean (median) total active saving over the five year period to the mean (median) of the sum of total family income over that same period. The mean age difference between households owning stocks and households not owning stocks was 1.5 years in 1984. Dollar values are in thousands of 1996 dollars.

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Table 2.—Saving by Stock Ownership

<table>
<thead>
<tr>
<th></th>
<th>Total Saving</th>
<th>Stocks</th>
<th>Total less Stocks</th>
<th>Saving Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full sample:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>24.6</td>
<td>20.2</td>
<td>3.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Median</td>
<td>7.6</td>
<td>5.4</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Do not own stock</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>15.7</td>
<td>16.2</td>
<td>0.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Median</td>
<td>4.6</td>
<td>3.7</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Own stock in 1984</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>47.7</td>
<td>30.5</td>
<td>8.8</td>
<td>13.3</td>
</tr>
<tr>
<td>Median</td>
<td>24.3</td>
<td>13.2</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

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6 Age groups are defined using the age of the head in 1984 for the period 1984 to 1989 and the age of the head in 1989 for the period 1989 to 1994. Thus, saving comparisons can be made without the confounding age effect.

7 Studies of the consumption-based CAPM have noted that the consumption of stockholders is more highly correlated with stock returns than that of nonstockholders (Mankiw & Zeldes, 1991).
the estimated wealth effect for a given asset. The first is attenuation bias resulting from classical measurement error. More unique to the current estimation problem is a bias introduced by the method used to construct capital gains. For a given change in wealth, a positive error in active saving necessarily lowers measured capital gains by an equal amount. Thus, measurement error in active saving artificially induces a negative correlation with measured capital gains. In general, the two effects of measurement error operate in opposite directions, and it is not possible to determine the direction of the overall bias.9

Eliminating the effect of attenuation bias is made difficult by a lack of valid instruments. But we are able to mitigate the second source of bias, a more critical problem in our application in that it unambiguously biases toward a larger negative effect. Our solution utilizes the availability of active saving and capital gains data. The second bias stems from a definitional link between measured capital gains and active saving. To avoid this bias, we eliminate from total active saving the assets whose capital gains we are most interested in, namely publicly held securities, so that such transfers do not contaminate the estimates of the wealth effect. Capital gains in assets other than stocks avoids the definition-induced bias as long as the errors in measurement are independent across assets.10

In the appendix, the bias is decomposed into its two effects, and its effect on the estimated coefficients is examined. 10

By restricting the analysis to saving in assets other than stocks, a decrease in saving may simply reflect shifting resources toward stocks rather than a decline in overall saving. Table 2 reports separately active saving in assets other than stocks and active saving in stocks. Not surprisingly, some portfolio reallocation appears to have taken place. For example, among households that owned stocks in 1984, mean active saving in stocks increased by approximately $4,500 between the periods 1984 to 1989 and as of 1989 for the period 1989 to 1994. Models are estimated using the fixed effects estimator; t-statistics are in parentheses.

Table 3 reports the estimated effects of household capital gains on active saving.11 The results in the first column of table 3 suggest active saving is quadratic in age. Marital transitions are captured by dummy variables indicating whether the household head got married and whether the household head got separated.12 Entry into marriage has little effect on changes in household wealth relative to households that did not change marital status. In contrast, a divorce or separation indicates a significant decrease in household wealth, most likely reflecting the withdrawal of assets from the original family unit. Finally, our estimates indicate that a dollar increase in income raises saving by roughly 8 cents.

We control for inheritances and net transfers into the household from gifts or loans and the liquidation of pensions, so that such transfers do not contaminate the estimates of the wealth effect. Net transfers in the form of gifts, informal loans, or pension liquidations do not appear to appreciably increase active saving, which may indicate that most of these resources are consumed.13 A dollar inheritance asset decreases by $21,700 for these households, a far larger decline than the increase in saving in stocks. More generally, the correlation between the change in active saving in stock over the two 5-year periods and the change in active saving in other assets is 0.02 and not statistically different from 0. Therefore, although households did reallocate their portfolio somewhat toward stocks, the magnitude of the reallocation is trivial relative to the overall decline in saving.

In our interpretation of these results, we are implicitly arguing that most of the capital gains over the past two decades were largely unex-pected. This argument is supported both by the observation that the sheer magnitude of the gains was unlike that in any other period in the history of stock market and by recent work on the equity premium by Fama and French (2002), who suggest that higher than average returns in the past two decades were largely unexpected.

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12 The reference group—those that either stayed married or stayed unmarried—represents 85% of the sample.

13 It seems plausible that gifts and informal loans, as well as some pension liquidations, are intended for immediate consumption. However, it is unlikely that consumption should be affected by a pension rollover.
increases household saving by 46 cents, but, as mentioned above, it is unclear how to interpret this effect, because the form in which the inheritance was received is unknown.

Our primary interest centers on the effect of capital gains on active saving. As shown in column i of table 3, a dollar increase in total capital gains reduces saving by approximately 3 cents over a 5-year period. However, this result substantially understates the effect of capital gains on saving, because the source of the capital gains matters a great deal. In column ii, the effect of capital gains on saving is separated by asset type. The results indicate that a dollar of capital gains in stocks reduces active saving by approximately 19 cents. In contrast, the effect of capital gains in housing is smaller in magnitude and statistically insignificant, and the effect of capital gains in other tangible assets is essentially zero.14

The remaining columns in table 3 present alternative tests of the robustness of our estimates. One possible explanation for the large capital-gain effect from stocks may be the lack of PSID information on capital gains in pensions. Households with large capital gains in privately held stocks might have received large gains in their defined-contribution pension plans, which were growing in popularity over the sample period. A positive correlation between capital gains in privately held equities and capital gains in pension equities would overstate the estimated effect of the saving response to privately held equity gains alone. Although we are constrained by limited pension information in the PSID, column iii in table 3 presents results from a model that includes the interaction between capital gains in the stocks and a dummy variable for the existence of a private pension for at least one spouse. Because those with a pension were likely to have larger total capital gains in stocks, the interaction term should be negative. Indeed, though the results suggest that the impact of capital gains in stocks is statistically significant for both those with and those without pensions, the effect is more than twice as large for those respondents with a pension. The difference in the size of the capital-gain effect between those with and without pensions does not necessarily suggest that these two types of households react differently to a given wealth increase. Rather, it may only indicate that the true size of the capital gain in corporate equities is larger for households with a pension.

Given the large effect marital transitions can have on changes in household wealth, column iv presents estimates restricting the sample to households that remained married in all three waves of the survey. The results show little difference from those based on the full sample, indicating that marital transitions do not affect our estimated relationship between active saving and capital gains. As highlighted in table 1, there is a strong relationship between education and the portion of the decline in active saving attributed to capital gains. Although estimated wealth effects in table 3 control for all household fixed effects including education, column v reports the estimated wealth effects when the sample is restricted to households whose head has at least some college education. The results suggest a somewhat stronger effect of capital gains in equities and are consistent with the relationship in table 1.

The results in columns i through iv contain the bias introduced by the one-for-one effect of measurement error in active saving on measured capital gains. As argued above, this bias can be mitigated by redefining active saving to exclude active saving in stocks. The results in columns vi through ix replicate those in columns i through iv using this redefined measure of active saving. Eliminating the bias reduces the magnitude of the wealth effect, as hypothesized, but by a trivial amount. The estimated effect of capital gains in corporate equities are reduced from −0.191 in column ii to −0.183 in column vi. This may not be surprising in that active saving in stocks is a small part of total active saving. Only classical measurement error remains once the effect of heterogeneity in saving behavior and the definition-induced measurement error are removed. This tends to bias the results toward finding no effect of stock market gains.

To further examine the robustness of the results in table 3, we considered two alternative methods of estimation. The first method applies the median regression estimator to models ii and vi in table 3. The second method estimates models ii and vi by first dropping observations that contain a high degree of leverage and yield a large residual, and then reweighting the remaining data with weights that are inversely related to the sample residuals.15 The effect of capital gains on active saving is reduced somewhat, to −0.154, when estimated by median regression, and to −0.121 when estimated by the reweighted regression. When saving in stocks is removed from active saving, the effect of capital gains in stocks is −0.148 and −0.161 when estimated by the median and reweighted regressions, respectively. All results remain highly significant, suggesting that our estimates in table 3 are quite robust.16

IV. Discussion

A. Accounting for the Decline in Personal Saving: 1984 to 1999

Can our estimated effects of capital gains account for the decline in the rate of personal saving in the United States?

14 Capital gains in the three components are roughly uncorrelated. As a result, the total wealth effect is approximately equal to the weighted average of the wealth effects of the three components. The weights reflect each capital gain component’s share of the variance in total capital gains. The relative shares for housing gains, stock gains, and other gains are 0.21, 0.22, and 0.57, respectively.

15 The criterion for the first stage of the estimation is to drop observations with a Cook’s D-statistic larger than 1.0 (Cook, 1979). Only one observation was dropped. In the second stage, weights are determined iteratively, based on within-sample absolute errors, as recommended by Huber (1964).

16 Results are available from the authors upon request.
B. How Plausible Are the Estimated Wealth Effects?

The wealth effect for stocks we estimate in the PSID seem larger than the consensus view. For example, a simple textbook model of consumption implies a marginal propensity to consume on the order of 0.04, a value consistent with the macroeconometric literature (Poterba, 2000). However, we are estimating the effect of capital gains over 5 years on saving over the same horizon. If consumption is proportional to wealth, the total saving response to a change in wealth should increase with the number of years over which a household can respond. But PSID households experienced capital gains over the entire 5-year period from 1984 to 1989 and from 1989 to 1994, not just in the initial year. Assuming that capital gains received by the PSID households followed a mostly uniform path similar to what occurred in the aggregate data, as indicated by the Federal Reserve’s Flow of Funds, the annual wealth effect from corporate equities would be approximately 0.07 cents per dollar of capital gain—still almost twice as large as indicated by the textbook model.

However, there are several reasons to expect the marginal propensity to consume out of wealth to be larger than indicated by the textbook model. If the planning horizon is the expected end of life, consumption from a gain in wealth should be allocated over the remaining years, implying a small saving effect from capital gains. But going back to the pioneering work of Milton Friedman, there is a large body of research suggesting that planning horizons are much shorter (Friedman, 1957). Retirement is not the only motive for saving. For motives such as saving for college expenses for children, horizons are much shorter, so that the effect of capital gains on saving may be larger. In addition, uncertainty and impatience, combined with liquidity constraints, generates buffer-stock saving behavior, which implies that households consume a much larger fraction of a wealth gain than the simple benchmark model suggests. Indeed, the estimate of the wealth effect from stocks in table 3 is on the lower bound of those simulated by Carroll (1997).

Another explanation for the size of our results relative to previous studies relates to the periodicity of PSID wealth modules. We are estimating the effect of capital gains over 5 years. Though this restriction was survey-induced, it may inadvertently bring an analytical advantage. The high-frequency relationship between household saving and the stock market is rather weak (Poterba & Samwick, 1995). Lettau and Ludvigson (2004) claim that as much as 88% of postwar variation in household wealth is generated by...
transitory innovations, whereas variation in aggregate consumption is dominated by permanent shocks. Given the extreme variability in stock prices, consumption-smoothing households may not want to vary their consumption to react to daily, monthly, or even yearly equity price movements. Significant short-run price variability could signal uncertainty regarding an asset’s value, and households might react with understandable caution in adjusting their consumption to any change in prices. Some changes in consumption, such as in that of durable goods, may have to meet threshold requirements before they take place (Grossman & Larroque, 1990). Similarly, consumption habit formation implies larger long-run than short-run responses to wealth change as households are more inclined to adjust their consumption slowly (Carroll, 1997). Whatever the reason, if individuals slowly adjust their consumption, the initial response to a capital gain may be substantially smaller than the 5-year effect we are estimating.

Our results are most closely aligned with those of Parker (1999), who also uses the PSID wealth data to examine the decline in the personal saving rate. Although Parker concludes that the increase in household wealth explains little of the decline in personal saving, this is based on an estimated total wealth effect that is entirely consistent with our results using total capital gains from column i of table 3. As indicated in table 4, very little of the decline in the personal saving rate can be explained by capital gains when applying a single total wealth effect to aggregate data. It is only when wealth effects are differentiated by asset type that capital gains are enough to explain the saving decline. The implication of our analysis for explaining the drop in personal saving and that of Parker’s is quite different.

C. Why Should Wealth Effects Vary by Asset Type?

Spending may differ across assets for several reasons. First, transaction costs in borrowing against housing equity may imply a lower marginal propensity to consume out of capital gains in housing relative to capital gains in equity. Second, the marginal propensity to consume may differ across assets due to varying perceptions of liquidity. That is, liquidity constraints can be self-imposed for behavioral reasons (Shefrin & Thaler, 1988). Households may not treat money stored in different places as perfect substitutes. Rather, they may divide their wealth into separate “mental accounts,” each with its own marginal propensity to consume owing to varying degrees of self-imposed liquidity. This argument could suggest that a dollar of capital gain is considered more discretionary than a dollar of existing wealth. This may be particularly true for gains in stocks that are largely unanticipated and viewed as windfalls.

Third, and perhaps most important, some assets serve more than one purpose. This is particularly true for housing, because homeowners are on both sides of the housing market. To many homeowners, house price increases may be seen as a mixed blessing. Younger households that own their own homes may see rising house prices as a problem if they desire to upgrade their homes in the future as their families grow. As a result, although housing is an instrument for savings, its additional role of a consumption good likely dampens the spending response to price appreciation.19

V. Conclusion

This paper has reached several conclusions. Most important, our results suggest that the decline in the personal saving rate since 1984 is largely due to the significant capital gains in corporate equities experienced over this period. Over 5-year periods, the effect of capital gains in corporate equities on saving is much larger than the effect of capital gains in housing or other assets. Failure to differentiate wealth effects across asset types results in a significant understatement of their size.

Additional tests of the effect of capital gains on saving would be desirable, particularly those that differentiate by asset type. One fruitful avenue to pursue may be cross-national differences. Countries differ significantly in the extent to which households participate in the corporate equity market as well as in the magnitude of local stock market fluctuations over time. Because countries also vary considerably in secular trends in national saving rates, the correspondence between country-specific saving rates and stock market indices provides a powerful test of the wealth effect. In addition, a better reconciliation of recent trends in household saving and consumption would help increase our confidence in the role that should be assigned to wealth effects in explaining household behavior.

REFERENCES


19 The magnitude of the effect of housing gains may seem small in light of the rising popularity of home equity loans. However, the growing use of home equity financing represents more of a structural shift in the financing market than a reaction to rising house values. For example, the value of home mortgages in the PSID increased as much in the period 1989 to 1994 as during the period 1984 to 1989, even though the value of homes was falling between 1989 and 1994 and rising between 1984 and 1989. Parker (1999) also concludes that financial innovation was unlikely to have caused the recent consumption boom.
where $s_t^*$ and $w_t^*$ are the true values of active saving and wealth, and $\epsilon_t$ and $\mu_t$ are independent measurement errors with variances $\sigma^2_{\epsilon_t}$ and $\sigma^2_{\mu_t}$.

By definition, capital gains are given as

$$g_t = w_t - w_{t-1} - s_t = g_t^* + (\mu_t - \mu_{t-1} - \epsilon_t), \quad t = 1, 2,$$

where $g_t^* = w_t^* - w_{t-1}^* - s_t^*$. Note that measurement errors in active saving and capital gains share a common component, $\epsilon_t$.

To control for the household fixed effect, which may be correlated with capital gains, the wealth effect is estimated using the relationship expressing how the saving of each household responds to the changes in their own capital gains. The changes in active saving and capital gains are given as

$$\Delta s_t = s_t^* - s_{t-1}^* + \epsilon_t - \epsilon_{t-1},$$

$$\Delta g_t = (w_t^* - 2w_{t-1}^* + w_{t-2}^*) - (s_t^* - s_{t-1}^*) + (\mu_t - 2\mu_{t-1} + \mu_{t-2} - \epsilon_t - \epsilon_{t-1}).$$

Consider the following regression of saving on capital gains (de-meaned), suppressing variation in $X$ for expositional purposes:

$$\Delta s_t = \beta \Delta g_t + \epsilon_t.$$

Estimation of $\beta$ by OLS yields

$$\hat{\beta}_{ols} = \text{Cov}(\Delta s_t, \Delta g_t) / \text{Var}(\Delta g_t).$$

The relationship between $\hat{\beta}_{ols}$ and the OLS estimate without measurement error, $\beta_{ols}$, is given by

$$\hat{\beta}_{ols} = \beta_{ols} \left( \frac{\text{Var}(\Delta g_t)}{\text{Var}(\Delta g_t) + 2\sigma^2_{\mu_t} + \text{Var}(\Delta s_t)} \right).$$

The relationship indicates that there are two effects of measurement error. The first expression in parentheses is the attenuation bias resulting from classical measurement error. More unique to the current estimation problem is the second term. Because this term is positive, the effect biases $\hat{\beta}_{ols}$ downward, making it more negative. This bias is a result of measurement error in active saving and the definition of capital gains: note that the numerator of the second term is $\epsilon_t$ rather than the variance of $g_t^*$.

The solution proposed in this paper is to eliminate the measurement error component of the covariance between active saving and capital gains by eliminating from active saving the assets whose capital gains we are interested in, namely corporate equities. Consider a model with two assets, $w_1$ and $w_2$, as well as the saving in each of these assets, $s_1$ and $s_2$. As above, we observe the saving and value of the two assets with error:

$$s_k = s_k^* + \epsilon_k, \quad k = 1, 2, \quad t = 1, 2,$$

$$w_k = w_k^* + \mu_k, \quad k = 1, 2, \quad t = 0, 1, 2.$$

We assume that measurement errors are independent across assets. The capital gains for each asset are defined as

$$s_k = s_k^* + \epsilon_k, \quad k = 1, 2, \quad t = 1, 2,$$

$$w_k = w_k^* + \mu_k, \quad k = 1, 2, \quad t = 0, 1, 2.$$

where $g_k^* = w_k^* - w_{k-1}^* - s_k^*$. Now consider the effect $\lambda$ of capital gains in asset 2 on saving in asset 1. As above, the model is estimated in first differences to eliminate household-specific fixed effects. In regressing $\Delta s_1$ on $\Delta g_2$, the covariance between the two variables reduces to $\text{Cov}(\Delta s_1^*, \Delta g_2^*)$, and the estimate of the effect of $\Delta g_2$ on $\Delta s_1$ is given by

$$\hat{\lambda}_{ols} = \frac{\text{Var}(\Delta g_2^*)}{6\sigma^2_{\epsilon_1} + 2\sigma^2_{\mu_1} + \text{Var}(\Delta s_1^*)}.$$

The definition-induced bias no longer exists, and we are only left with attenuation bias.

20 Allowing the variances of the measurement errors to change over time or display serial dependence does not affect the main result.