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Abstract

We compile and analyze detailed information on the debt structure and interest rate derivative positions of nonfinancial firms in 2000 and 2002. We find that differences in debt structure across firms and time tend to be counterbalanced by differences in derivative positions. In particular, among derivative users, smaller firms tend to have relatively more interest rate exposure from liabilities than larger firms and tend to use derivatives that offset these exposures. Larger firms also tend to limit their interest rate exposures, but they do so through their choice of debt structure rather than with derivatives. On the other hand, we find that a large fraction of the change in derivative positions over time cannot be explained by changes in debt structure. Finally, we find no evidence that nonfinancial firms hedge interest rate exposures from their operating assets, but do not see this as supporting the hypothesis that firms use derivatives to speculate.

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I. Introduction

While the use of interest rate derivatives has grown substantially over the past few decades, recent research has questioned their importance and their efficacy in the risk management toolbox of nonfinancial firms. In particular, Guay and Kothari (2003) argue that derivative positions are generally too small to meaningfully affect firm value, whereas Faulkender (2004) shows that firms in the chemicals industry appear to use interest rate derivatives to speculate rather than to hedge. These recent findings go against the grain of most of the early empirical research on derivative use, which attempted to infer why firms hedge risks – beginning with the identifying assumption that derivative use is an indicator of the propensity to hedge.[1]

Our paper takes a closer look at how interest rate derivatives are used by nonfinancial corporations, both large and small, by examining the relationship between derivative positions and risk exposures. Our data set consists of detailed information on interest rate derivative positions of more than 500 nonfinancial corporations we identify as having positions in 2000 or 2002. These data allow us to focus on the relationship between a firm's derivative position and the structure of its debt and directly test whether firms hedge the interest rate exposures from their liabilities. We also gauge the relationship between derivative positions and the interest rate sensitivity of operating cash flows before interest expense, in order to test whether firms hedge exposures from their operating assets.

Our findings provide a nuanced view of the role played by interest rate derivatives in hedging interest rate exposures from the liability side of the balance sheet. Cross-tabulations on firms with derivative positions show that, compared to larger higher-rated firms, the smaller and lower-rated firms have substantially greater interest rate risk exposure from short-term and floating-rate debt. In some sense, this comparison of debt structures is a recalibration of the widely-cited empirical finding that small low-rated firms are more reliant on short-term debt (e.g. Barclay and Smith, 1995; Guedes and Opler, 1996); however, our measure of debt structure facilitates the comparison of interest-rate risk exposures.

[1] For instance, studies of interest rate derivative use (e.g., Graham and Rogers, 2002, Howton and Perfect 1998, Mian, 1996) assume that non-financial firms use interest rate derivatives to hedge and then test whether derivative use is correlated with variables that proxy for theories about why firms hedge.

This cross-sectional pattern of debt structure has been rationalized by the financial contracting literature. For instance, Flannery (1986) argues that informationally opaque (small, lower-rated) firms are induced to borrow short-term to signal private information about credit quality. Diamond (1991) suggests that young firms are relegated to borrow from banks due to reputational concerns. Since banks tend to lend short-term and at floating interest rates, this implies -- all else the same -- less mature firms would tend to have higher exposures to interest rate risk.

At the same time, we find that the smaller and lower-rated firms tend to have interest-rate derivative positions that counterbalance their greater liability-generated interest-rate exposures, as predicted by Titman (1992). Indeed, after accounting for derivatives, the "net interest-rate exposures" of small and large firms tend to be similar and relatively modest. This suggests that small firms limit their interest rate exposure with derivatives, whereas large firms do so by financing with long-term fixed-rate debt. Our regression analysis confirms, more broadly, that differences in debt structure across firms and time tend to be counterbalanced by differences in derivative positions -- further evidence that derivatives are used to hedge.

The finding that small firms tend to hedge their greater exposure to interest rate risk is consistent with the theory of Froot, Scharfstein, and Stein (1993), which suggests that derivatives can reduce average financing costs by reducing fluctuations in the demand for external financing, particularly for informationally opaque firms. The finding that firms of all sizes seem to limit their interest rate exposure--smaller firms with derivatives and larger firms with their debt structure--is consistent with a number of theories that argue firm value is enhanced by a reduction in cash flow/income volatility.[2]

A few other studies have explored the link between interest rate derivatives and debt structure. Graham and Rogers (2002) analyzed the magnitude of derivative positions and finds that firms appear to use foreign exchange and interest rate derivatives to increase debt capacity, and Visvanathan (1998) finds that long-term debt and leverage

[2] These theories include Froot, Scharfstein, and Stein's (1993) theory just discussed. In addition, firms may have an incentive to lower expected distress costs and allow greater leverage (thus greater tax benefits), as discussed in Smith and Stultz (1995); they also suggest the potential incentive to lower income volatility that derives from the convexity of the tax structure or managerial risk aversion. Finally, managers may hedge to more precisely convey private information about their ability (as in Breeden and Viswanathan 1998), or about the firm (as in DeMarzo and Duffie 1991).

appear to induce firms to swap interest payments from fixed to floating rates. Our analysis goes beyond these studies by constructing a derivative position measure that gauges both magnitude and direction of the position, and by linking this to the size of interest rate exposure from liabilities.

Turning to the asset side of the balance sheet, we find no evidence that non-financial firms hedge the interest rate exposures from their operating assets, consistent with Faulkender (2005). However, our analysis suggests these results may reflect the fact that operating exposures are difficult to measure -- not just for the econometrician but also for the firms themselves. More generally, it seems logical that firms use derivatives to hedge only those exposures that they can reliably measure. In the case of interest rates, the measurable exposures appear to be from liabilities rather than assets. This view is consistent with Allayannis and Ofek's (2001) finding that firms appear to use currency derivatives to hedge exchange rate exposures, as firms can gauge these exposures as relatively simple functions of expected foreign sales and trade.

The paper proceeds as follows. In Section II, we discuss our data sources and variable construction, including the identification of interest rate derivative users and the measurement of derivative positions. Section III presents a nonparametric analysis of underlying interest rate risk exposures and provides broad evidence of hedging. Section IV presents the results of regression analysis of firm-level derivative positions. Section V concludes.

II. Data Sources and Construction of Key Variables

1. Data on Derivative Use

Information on interest rate derivative positions was gathered on a sample of over 3000 publicly traded nonfinancial corporations using *Compact Disclosure, Edgar* and *Compustat.* Our broadest universe of firms satisfied the following: (i) the firm had at least $100 million in total assets and is not a subsidiary; (ii) the firm's primary SIC is nonfinancial, that is, not between 6000 and 6999; (iii) the June 2003 *Compact Disclosure* disk contained the firm's 10-K text from fiscal year 2002 (or 2001 if fiscal year ended after April); (ii) the firm could be matched with data from Compustat. Finally, we imposed analogous criteria regarding availability of data from two years earlier (usually 2000). Together, these criteria yield a sample of about 2600 firms.

To gather information on a firm's use of interest rate derivatives, we begin by searching the text fields of each firm's latest 10-K and annual report on *Compact Disclosure*. We screened for keywords indicating the possible presence of disclosures of derivative use (specifically, DERIVATIVE DERIVATIVES, HEDGE, HEDGING, HEDGED, FUTURES, SWAPS, or SWAP). This screen identified a sample of roughly 1300 potential interest rate derivative users, roughly half the original sample.

Next, the financial disclosures, particularly 10-Ks and relevant portions of consolidated annual reports, of these potential users were individually searched to identify current use of derivatives and extract specific information about outstanding derivative positions at the end of fiscal years 2000 and 2002. Almost without exception, the interest rate derivatives that firms reported using fell into one three categories: swaps, caps, or collars.[3] If available, we record a firm’s outstanding notional amounts of pay-floating and pay-fixed swaps or, if not, its net swap position (or, if not, the direction of the net position). We also record the notional amount of any interest rate caps or collars.

As shown by the bottom row in Table 1, 497 firms were identified as active users in 2000, or about a fifth of the firms in our sample. The number of firms identified as active users in 2002 rises to 616, or nearly a quarter of the sample. The top three rows show that the positive relation between a firm’s size and its propensity to use derivatives, exhibited in previous studies, is evident here as well. On average over the two years, roughly half of the “large” firms in our sample, those with over $5 billion in assets, report using interest rate derivatives. This propensity drops to less than 15 percent among the small firms, those with under $1 billion (but at least $100 million) in assets. Not surprisingly, derivative users account for a greater than proportionate amount of the outstanding debt. For instance, users accounted for 24 percent of the small-firm debt (in 2002), and 71 percent of the large-firm debt.

Table 2 shows the propensity to use interest rate derivatives broken down by senior debt rating. The pattern tends to mimic the size groups, which is not surprising given the strong correspondence between firm size and rating. While unrated firms account for roughly a quarter of the users in each year (167 of 616 in 2002), only about

[3] In the few cases where notional figures for interest rate swaps were denoted solely in foreign currency, we converted to dollars using historical end-of-year exchange rates.

ten percent of the unrated firms use derivatives. On the other hand, over half of the firms with investment grade ratings -- the top two ratings groups – used derivatives in 2002.

2. Gauging Derivative Positions in 2000 and 2002

As mentioned above, we extracted available information on the types of derivatives used (i.e. swaps, caps, collars), as well as the direction and notional amount of each type. Interestingly, the overwhelming majority of interest rate derivative users reported using swaps. Indeed, of the 578 users in 2002 that report (net) notional values of their positions, 512 report having only swaps only, 24 report having caps or collars and no swaps, with the rest (42) reporting both swaps and caps/collars.

Our primary quantitative gauge of a firm's net derivative position is the net notional value of a firm's pay-floating swaps, where we treat a pay-fixed swap position as a negative pay-floating position. (Think of a positive position as measuring the increase in interest rate exposure coming from swaps.) For firms with caps (or collars), the notional value of those caps was treated the same as pay-fixed swap positions. Of course, in some cases this can produce a pretty rough measure of derivative position, since the delta of out-of-the-money caps can be considerably less than one; however, limited information precludes a more elaborate measure.[4]

Table 3 provides descriptive statistics on firms' derivative positions. Perhaps the most interesting statistics appear in the first column, document the direction of usage. In the 2000 fiscal-year data, the vast majority (369) of the nonfinancial firms using derivatives were identified as having a pay-fixed position, on net, whereas only 88 firms had net pay-float position. There is a notable shift, however, in the 2002 data, in which the number of sample firms holding pay-floating positions jumps to 201, whereas the number of firms with pay-fixed positions declines slightly.

The statistics to the right show the distribution of the magnitude of derivative positions. To normalize for firm size and debt exposure, notional values are reported here as a proportion of the book value of firm total debt. For instance, in 2000, the

[4] Thus, for firms having caps or collars, our measure represents an upper bound on the position. Nonetheless, due to the dominant role of swaps, the distribution of exposures is not affected substantially by including caps and collars; and we check the robustness of our results using the subsample of firms that only have swaps.

median pay-floating notional swap position was equal to 15.8 percent of firm debt, while the median pay-fixed position was equal 28.3 percent of firm debt. It bears pointing out that, for firms beyond the 75 percentile, derivative exposures are quite substantial relative to the level of the firm's debt. Indeed in 2002, the 75th percentile exposure among firms with net pay-floating positions was 34.4 of total debt, and it was 60 percent of total debt among firms with pay-fixed positions.

3. Measuring Interest Rate Risk Exposures

a. Interest-rate risk from debt

Using data from Compustat and firm 10-K's, we construct a dichotomous measure of each firm's debt structure analogous to our measure of derivative positions.[5] We divide a firm's debt into two categories, (i) fixed-rate long-term debt and (ii) floating-rate debt. The latter category includes all debt with market-sensitive interest payments, which create cash flow risk that firms might wish to hedge (with pay-fixed swaps). In particular, floating-rate debt is measured as the sum of debt due within a year (debt in current liabilities) and long-term floating rate debt (floating-rate debt with maturity greater than a year). Thus, fixed-rate debt is defined as long-term debt minus long-term floating-rate debt.

While not obvious at first blush, this dichotomy of corporate debt into variable-rate and fixed-rate debt is not very different from the dichotomy one might use for testing theories of optimal debt maturity. Those theories analyze the optimal borrowing horizon from an agency perspective, in which the key concern is the frequency over which the creditor can adjust the credit spread. The potential mismatch between these two dichotomies owes to the presence of "long-term" floating-rate debt. Much of that debt is actually bank loans, where "term" is an ambiguous concept. While treated as long-term from an accounting perspective, bank loan contracts tend to leave lender and borrower substantial flexibility to terminate or renegotiate key terms *before* the maturity date. Indeed, Barclay and Smith (1995) argue that call provisions, prepayment options, and affirmative covenants can result in effective maturities that are significantly less than

[5] Because the reporting on floating-rate debt in Compustat is uneven, at best, we use 10-K footnote on debt structure to help fill in or correct the debt structure measures.

stated maturities. Thus, we think of long-term floating-rate debt (and thus our measure of total floating-rate debt) as more akin to short-term debt from an agency perspective.

b. Interest-rate risk from assets (operating earnings)

Unlike the interest rate risk from the firm's debt, interest rate risk arising from the operations of nonfinancial firms -- the relationship between operating cash flows with interest rates -- is normally unobservable and must be estimated (both by us and by the firm). To do so, we extract from *Compustat* for our sample of firms the annual values of operating earnings before interest and depreciation (EBITD) and end-of-year assets (A), from 1983 to 2002 or to the extent available. Importantly, this measure of earnings from operations excludes debt service (and net payments from interest rate derivatives). We estimate the following regression:

$$EBITD_{it}/A_{it} = a_{0i} + a_{1i}t + \beta_i r_t + e_{it}\,.$$

where r_t is the average value of the LIBOR interest rate during fiscal year *t*.

In this regression, a_{0i} is a constant, β_i measures the sensitivity of operating earnings, scaled by book value assets, to market interest rates, and e_i is the random component of project returns uncorrelated with the risk-free rate. A time trend is included in order to guard against spurious inference that could arise if independent trends existed in both interest rates and a firm's operating profitability over the estimation period. Such a precaution seems important in light of the fact that interest rates have generally trended downward over the period since the early 1980s.[6]

For many firms, the annual data is not available for 20 years; and in some cases, we only have the data for a handful of years. To compensate for this, we also estimate interest-rate betas at the 3-digit SIC industry-level using analogous regressions in which all firms in a given industry are pooled into a single regression, run separately for each 3-digit industry. In those cases where the firm-level beta is estimated with 15 observations or fewer (317 of 723 firms), the industry-level estimate is used in its place.[7]

[6] A variation on this specification that would be closer in spirit to the framework of Froot, Scharfstein, and Stein (1993) would have operating earnings net of optimal investment, $(EBITD_i - I^*_i)/A_i$, as the dependent variable. However, we only observe actual, rather than desired, investment; and the discrepancy between actual and optimal investment is presumably influenced by interest rates, absent complete hedging.

[7] As it turns out, substituting the industry-level interest-rate betas has no measurable effect on the results.

III. Descriptive Analysis of Interest Rate Exposures

This section examines the variation in interest rate exposures that arise from liabilities and assets for broad groupings of firms by size and rating. In addition, we explore whether the broad pattern of interest rate risk exposures and derivative positions is consistent with firms using derivatives to hedge. In short, we find that, among users of derivatives, smaller firms tend to have the most substantial interest rate exposures from liabilities and are also most prone to use swaps to reduce interest rate exposure.[8] In contrast, we find no measurable differences across size groups in the interest rate exposures from assets.

1. Interest Rate Exposure from Liabilities

As shown in figure 1a, among derivative users (shown by the dark bars), smaller firms tend to have much more floating-rate debt as a fraction of assets compared to large firms. The median floating-rate debt ratio in 2000 was about 14 percent for large users, 20 percent for medium-sized users, and 26 percent for small users. In fact, the average ratio for the medium group is significantly different from that of the other two groups at the 95 percent confidence level. In contrast, as shown by the light bars, most firms that do not use derivatives ("nonusers") have comparatively little floating rate debt, irrespective of size. Median floating rate debt-to-asset ratios for large, medium, and small nonusers were only about 5 percent in 2000.

Another interesting and related grouping is by credit rating. As shown by the dark bars in figure 1b, the lower-rated and unrated derivative users tend to have the most floating rate debt. In particular, the median floating rate debt-to-asset ratio for users rated A (and above) was only 10 percent in 2000, and for users rated BBB was 17 percent. In contrast, the median ratio for users rated BB and below was 30 percent, and for unrated users it was 24 percent. The light bars again highlight the relative paucity of floating rate debt among nonusers, except in the case of A-rated firms, where there is little difference between users and nonusers.

These cross-sectional patterns of floating rate debt use can be rationalized by the literature on financial intermediation. Since banks tend to lend short-term and at variable interest rates, our finding that small, or low-rated, derivative users have larger floating

[8] Ratings are issuer-level, long-term credit ratings from S&P, available from the Compustat database.

rate debt-to-asset ratios than the other groups of firms is consistent with them being more reliant on banks for financing. This would suggest that it is for these firms that interest rate derivatives should have their greatest utility as instruments for hedging.[9]

2. Exposures from Liabilities Net of Swaps

A simple way to assess the broad pattern of interest rate derivative usage is to examine how swap positions affect the pattern of *net* interest rate exposures arising from liabilities. We measure net exposures as the sum of floating-rate debt outstanding and the reported notional value of pay-floating swaps (the negative of notional pay-fixed swaps). As shown in Figure 2a, netting out derivative positions reduces the median interest rate exposure among large users in 2000 only marginally, from 11 percent to 9 percent. In contrast, derivatives lowered the median interest rate exposure of medium-sized users from about 20 to 10 percent. The largest impact of swaps on net exposures is among the small users, where netting swap positions produces a drop in this measure of median interest rate exposure from 27 to 13 percent. In contrast to the floating-rate debt ratios, the average net exposure for each size group is not significantly different from that of the other groups.

Chart 2b shows the analogous statistics on net floating-rate debt exposures for firms grouped by broad credit rating category. As shown, derivatives have almost no impact on the median net interest rate exposure of the highest-rated firms. In contrast, the median net exposure of firms rated BB or below was reduced from 30 to 14 percent while that for unrated firms was reduced from 23 to 11 percent. Thus, the broad pattern of derivative use appears consistent with the idea that firms that are more reliant on floating-rate debt generally use interest rate derivatives to offset their higher exposures to floating-rate liabilities. Indeed, after taking account of derivative positions, the average net interest rate exposure is pretty much equalized across groups.

To complete the comparison of debt structures, Chart 3a plots the median ratio of fixed-rate (long-term) debt to assets in 2000, by size group. This debt ratio is about 20 percent for large users, 16 percent for medium-sized users and only 5 percent for small

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[9] Large firms may find it more efficient to access the corporate bond market than smaller firms, the primary source of fixed-rate long-term debt, perhaps because of the fixed costs associated with bond issuance (e.g., rating and investment-banking fees). Among firms with credit ratings, higher-rated firms may also find the corporate bond market more accessible, if such firms are less prone to "information problems." Asymmetric information is traditionally cited as the reason for why banks (i.e., monitoring lenders) exist.

users. Interestingly, as shown by the light bars, the median fixed-rate debt ratio for nonusers is quite similar to that for users in the same size group. As shown in Chart 3b, the similarity between users and nonusers also holds up when firms are broken out by broad ratings group.

Indeed, that there is little difference between the fixed-rate debt ratios of users versus nonusers stands in sharp contrast to the sizable differences that show up in the pattern of floating-rate debt ratios. On the face of it, these results point to a plausible refinement a key result in Graham and Rogers (2002), who conclude that using derivatives allows firms to boost their leverage. Our finer parsing of the data indicates, more specifically, that the use of derivatives by nonfinancial firms allows them to use more floating-rate debt in particular. Indeed, putting it all together, our data suggest that large firms tend to limit their interest rate exposure by using fixed-rate long-term debt (instead of floating-rate debt), whereas small firms appear to rely on derivatives to offset sizeable interest rate risk exposures from floating-rate debt.

3. Changes in Exposures from Liabilities

Further insight into the use of interest rate derivatives is gained by examining changes in the pattern of debt structures and interest rate derivative positions between 2000 and 2002. As shown in Chart 4a, we find that the median floating-rate debt ratios in each size category of users dropped about 10 percentage points from 2000 to 2002. The declines were also widespread across broad rating category (Chart 4b). Nonetheless, it appears that average *net* exposures to interest rates (that is, exposures net of derivatives positions) changed much less between 2000 and 2002. Thus, it would appear that on average, firms adjusted derivative positions so as to offset the effect on interest rate risk exposure due to the shift in debt structure.

Apparently, firms exhibited a propensity to offset, or hedge, the reductions in their floating rate debt with a shift towards pay-floating swaps.[10] Thus, it would appear that, both in the cross-section as well as over time, interest rate derivatives were used to

[10] As an aside, it is worth noting that at the group level the decline in floating-rate debt appeared only to coincide with an increase in fixed-rate debt for the two largest groups. The median fixed rate debt ratios of large and medium-sized firms both increased about 7 percentage points between 2000 and 2002. In contrast, the median fixed rate debt ratio for small users edged down slightly between 2000 and 2002, consistent with our assertions that such firms may have relatively limited ability to issue fixed rate, long-term debt.

produce a convergence in interest-rate exposures, perhaps toward some optimum level determined by other factors.

4. Interest-Rate Rate Exposures from Assets

Before turning to the regression analysis, we examine the cross-sectional pattern of interest sensitivity of firm operating earnings (before interest) as reflected in our interest-rate beta estimates. The first row of Table 4a shows the distribution of firms' interest-rate betas. For comparison, the distribution of interest rate exposures from floating-rate debt in 2000 and 2002 is shown in the second and third rows. The median interest-rate beta is 0.13; thus, for the median firm, a two-percentage point jump in interest rates would coincide, on average, with a 0.26 percentage point (26 basis point) increase in operating return on assets. This is about the same magnitude as the interest rate risk associated with the median floating-rate debt ratio (0.11 in 2002), though with the opposite sign.

The 90th percentile value beta is about 1.0, which means that a 2 percentage point rise in interest rates would be accompanied, on average, by a 200 basis point rise in operating return on assets.[11] At the other end, the firm with the 10th percentile (-0.64) beta would experience, on average a *drop* in return on assets of 128 basis points from such a change in interest rates.

Indeed, this range of exposures (from 1.0 to -0.64) implied by our of interest-rate beta estimates is much larger than the range of exposures associated with firms' floating-rate liabilities (and the comparison would be even more lopsided at the 5th to 95th percentiles). As shown in lines 2 and 3 of Table 4a, the floating rate debt to assets ratio varies from about zero to 0.4, for firms with exposures ranging from the 10th to 90th percentiles. In other words, our cross-section of derivative users appears to face a much wider range of earnings sensitivities arising from the correlation of operating earnings (EBITD/A) with interest rates than from their liabilities. Indeed, if the firm with an interest-rate beta of 1.0 were to try to fully offset that estimated exposure with pay-floating swaps (or floating-rate debt), it would need swaps with a notional value equal to the value of total assets (or a floating-rate debt-to-asset ratio of 1.0).

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[11] If this firm had a fairly typical return on assets of 8 percent, this would represent a 25 percent increase in earnings and return.

But this inference abstracts from a very critical issue, one which Faulkender (2004) largely ignores: These interest-rate betas are measured with a considerable degree of error. Indeed, the median standard error among our beta estimates is nearly 0.5. Thus, take a hypothetical firm with a beta of 0.75, which is estimated with a standard error of 0.5. The ninety percent confidence interval for this firm's interest rate beta (plus or minus 1¾ standard errors) would run between about -0.1 to 1.6. This range of uncertainty is huge, four times larger than the range of floating-rate debt exposures in the table. Thus, the degree of uncertainty around the perceived interest rate beta for many firms might well be so large that attempting to hedge this estimated risk could blow up their cash flow volatility. To make matters worse, as econometricians, we only observe *our* estimate of the firm's perceived beta, an error-in-variables problem. Thus, even if some firms were hedging this risk, any relation between our interest-rate beta estimates and firm swap positions is likely to fall far short of that implied by full hedging, or a coefficient of one.

Table 4b shows the distribution of firm-level betas for each of the three size categories.[12] The medians of all three distributions are quite close, ranging from 0.11 to 0.21, while their inter-quartile ranges are also remarkably similar. Clearly, in this simple univariate comparison, there is no obvious difference in the interest rate betas across size groups that might explain the pattern of swaps (or floating-rate debt) usage across those groups. In the next section of this paper, we test the relationship formally by including the betas as explanatory variables in firm-level regressions of swap positions.

IV. Regression Analysis of Hedging

This section presents results from regression analysis of the determinants of firm-level swap positions, defined as the notional value of pay floating swaps less pay fixed swaps (over assets). Regressions include only firms that actually have interest rate derivatives (in the given year); thus, the effects can be interpreted as being conditioned on the firm having made the choice to use derivatives. All regressions are estimated

[12] To calculate the statistics in this table, we drop all observation for which we substituted the industry-level beta (as discussed above, this was done when there were less than 15 annual observations with which to estimate the beta).

using "robust" regression techniques, which limit the impact of outliers on the coefficient estimates.

1. Cross-Sectional Regressions

Our benchmark specification for 2000 is shown in the first column of Table 5. Here, the notional value of swaps (as a fraction of assets) is regressed on the firm's 2000 floating rate debt (as a fraction of assets) and the firm's estimated interest rate beta. The coefficient on the floating rate debt ratio is -0.46, with a standard error of only 0.03, while the constant and the coefficient on the interest rate beta are both near zero and insignificant. The coefficients imply that, on average, firms tended to eliminate about half of the (above-average) floating-rate interest risk arising from their liabilities. On the other hand, they did not hedge the interest rate risk in their operating earnings.

The next two specifications demonstrate the robustness of these results. In the second column, we treat floating-rate debt as endogenous and instrument with some-firm-level financial variables: log of total assets, R&D to sales ratio, book-to-market value ratio, total debt-to-assets, a dividend-payer dummy, and dummy variables for broad rating group (A, BBB, and BB). The IV approach addresses the potential endogeneity of debt structure choice with respect to the choice of derivative position. As shown in the second column, the results are nearly identical when we instrument for the firm's floating rate debt to asset ratio.

The third specification augments the first specification by adding the firm's fixed-rate debt-to-asset ratio. Under the hypothesis that firms use interest-rate derivatives to hedge the interest-rate risk in their income or cash flow, the firm's fixed-rate debt would have no marginal explanatory power for swap positions. Indeed, we find that swap positions were not statistically related to fixed-rate debt in 2000.

The last three specifications in Table 5 repeat these regressions for 2002. In short, the results are mostly similar to those obtained using the 2000 data. The only notable difference is that, in the final specification, the coefficient on the firm's fixed-rate debt ratio in 2002 is 0.25 and significant. In addition, the coefficient on the interest-rate beta in this last specification is significant at the 5 percent level but still quite small.

The finding that firms boosted pay-floating swaps (reduced pay-fixed swaps) about 25 cents for every extra dollar of fixed-rate debt on their balance sheets in 2002 does not comport with the basic model of hedging implicit in our analysis. We have assumed up to this point that floating-rate debt ratios and cash-flow betas should be sufficient for explaining swap positions, which is what we find in 2000. One plausible interpretation is that more highly leveraged firms (those with more fixed-rate debt, holding floating-rate debt constant) were more prone to speculate on interest rates in order to reduce near-term interest expenses.[13]

To examine *which* firms tend to use swaps to hedge, we estimate four additional swap regressions, the results from which are shown in Table 6. In these regressions, the slope coefficient on floating-rate debt is allowed to vary across size groups. The first specification includes four independent variables: the interest rate beta and the floating rate debt ratio (in 2000) interacted with each of the three size-group dummies. As shown, the coefficients on small and medium firm floating-rate debt ratios are -0.45 and -0.42, respectively, both significant at the 1 percent level. In contrast, the coefficient on the large firm interaction is small and insignificant. This suggests that small and medium firms had a high propensity to hedge their interest-rate exposures in 2000, but large firms did not appear to be hedging the differences in their floating-rate liabilities.

The second specification augments the first by including group-level effects off firm fixed-rate debt. The group-level coefficients on floating-rate debt are largely unaffected, while the size-group coefficients on fixed rate debt are near zero and insignificant.

The results are somewhat different in 2002. The coefficients on the small, medium, and large firm interactions are -0.56, -0.34, and -0.24, respectively, and all three are significantly different from zero at the 1 percent level. Similar to 2000, the propensity to hedge floating liabilities with swaps is greatest for smaller firms, though here there is also evidence of hedging by large firms, albeit to a lesser degree. As shown in the fourth column, allowing for size-specific coefficients on fixed-rate debt ratio interactions does not qualitatively change the floating-rate debt coefficients. However, all three fixed rate debt ratio interactions are significant. This suggests that whatever is driving firms to swap fixed debt to floating in 2002 is pervasive across all size categories.

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[13] In June 2002 the three-month T-bill rate was about [300] basis points below the yield on ten-year Treasuries.

2. Regressions Explaining Changes in Swap Positions

Our final perspective on how derivative users employ these instruments comes from examining the extent to which changes in firm swap positions between 2000 and 2002 were related to changes in firm debt structure. This approach has the advantage of reducing potential omitted variables bias, by removing unobservable firm characteristics (fixed effects) such as the interest-rate sensitivity of operating earnings, which in the cross-section would be correlated with the firm's desired position.

The first two specifications, shown in table 7, are estimated on those firms that were users in both 2000 and 2002. As shown in column 1, the change in floating rate debt-to-assets ratio has a coefficient of -0.18, which is statistically significant. However, this coefficient is quite a bit smaller than that in the cross-sectional regressions, while the R-squared is substantially lower. In the second specification, the slope coefficient on floating-rate debt is allowed to vary across firm size category. In contrast to cross-sectional results, here it appears that the medium and large firms, but not the small firms, use changes in swap positions to hedge changes in floating-rate debt. The third and final regression applies the same specification, but on the complementary subset of firms -- those that were users in one year but not in the other year. Here, we find stronger evidence that firms hedge *changes* in debt structure; moreover, similar to the cross-sectional results, the largest coefficient is on floating-rate debt of the smaller firms.[14]

The more mixed results for changes in positions could owe to measurement difficulties resulting from timing discrepancies. For instance, firms may take swap positions to lock in an interest rate prior to issuing debt. Alternatively, one could infer that adjustments to swap positions over time are more heavily influenced by speculative motives – the desire to fine tune exposure in concert with changes in the expectations (of firm management) regarding the trajectory of interest rates. This behavior is not necessarily inconsistent with the finding that liability hedging explains a great deal of cross-sectional variation in swap positions, since changes in derivative positions tend to be smaller than cross-sectional differences. This interpretation would reconcile our

[14] The results are qualitatively similar if we estimate the same specifications in Table 7, but redefine all the change variables to be expressed relative to assets in 2000. For example, rather than use the change in the floating-rate debt-to-asset ratio, we take the change in floating rate and normalize it by assets in 2000.

findings with Faulkender (2005), who concludes that the *incremental* decisions on interest rate exposure are influenced by speculative motives.

V. Conclusion

Focusing on nonfinancial derivative users, we find that smaller lower-rated firms tend to have greater interest rate exposures from their liabilities than larger firms, but that this extra exposure tends to be offset by larger positions in pay-fixed swaps. Indeed, after accounting for derivatives, the *net* interest-rate exposures of small and large firms that arise from liabilities and derivatives are much more similar and for the most part reasonably modest. Cross-sectional regressions confirm more generally this propensity for firms to have derivative positions that offset a large fraction of the differences in their interest rate exposure from liabilities. Evidence for hedging behavior is somewhat weaker when we look at *changes* in derivative positions. Finally, there is no evidence to suggest that derivatives are systematically used to offset interest rate exposures from operating assets, although errors in estimates of operating exposures limit the power to test this.

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Table 1

Number of Derivative Users by Firm Size

Group* (1)	2000 Sample (2)	2000 Users (3)	2002 Sample (4)	2002 Users (5)	Percent of Group Debt Users 2002 (6)
Small	1620	201	1626	237	24.1
Medium	608	171	600	213	45.4
Large	289	125	291	166	71.1
Total	**2517**	**497**	**2517**	**616**	

* Large firms have total assets from $5 billion. Medium firms have assets from $1 billion to $5 billion. Small firms have assets less than $1 billion.

Table 2

Number of Derivative Users by Firm Credit Rating

Group (1)	2000 Sample (2)	2000 Users (3)	2002 Sample (4)	2002 Users (5)	Percent of Group Debt Users 2002 (6)
Unrated	1479	145	1438	167	21.5
BB (or lower)	517	143	575	174	46.9
BBB	293	110	304	160	72.8
A (or higher)	228	99	200	115	74.9
Total	**2517**	**497**	**2517**	**616**	

Table 3
Distribution of Derivative Positions

			Swaps as a Fraction of Total Debt*				
		No. Obs.	10th	25th	Median	75th	90th
2000	Pay-Floating	88	0.02	0.04	0.16	0.31	0.47
	Pay-Fixed	369	-0.05	-0.14	-0.28	-0.51	-0.83
	No direction	15					
	Unknown	25					
2002	Pay-Floating	201	0.05	0.11	0.18	0.34	0.48
	Pay-Fixed	359	-0.05	-0.14	-0.32	-0.6	-0.97
	No direction	23					
	Unknown	33					

*Notional value of pay-floating interest rate (IR) swaps minus the notional value of pay-fixed IR swaps, caps and collars, as a percent of total debt.

Table 4
Distribution of Interest Rate Risk Exposures for Users

	10th	25th	Median	75th	90th
2000 Floating Debt / Assets *	0.02	0.08	0.19	0.31	0.42
2002 Floating Debt / Assets *	0.01	0.04	0.11	0.23	0.39
Interest Rate Beta **	-0.64	-0.31	0.13	0.65	1.02

*Floating debt / Assets is equal to short-term debt plus long-term floating rate debt over assets.

**Interest rate beta is estimated coefficient from firm level or 3 digit SIC industry regression of OIBDP / Assets on 3-month LIBOR rate.

Table 5

Regressions of Swap Positions on Exposures

	2000			2002		
	(1)	(2) [1]	(3)	(4)	(5) [1]	(6)
Const.	0.01	0.02	0.00	0.03 **	0.02	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
FLD/A	-0.46 **	-0.51 **	-0.45 **	-0.50 **	-0.40 **	-0.43**
	(0.03)	(0.05)	(0.03)	(0.03)	(0.05)	(0.02)
FXD/A			0.03			0.25 **
			(0.03)			(0.02)
Interest Rate Beta	0.01	0.01	0.01	0.01	0.01	0.01 *
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Nobs	390	390	390	483	483	483
Adj-R^2	0.39	0.30	0.39	0.44	0.23	0.52

* denotes significant for p-value of 0.05.
** denotes significant for p-value of 0.01.
The dependant variable is the notional value of pay-floating interest rate (IR) swaps minus the notional value of pay-fixed IR swaps, caps and collars, as a percent of total assets.
1. FLD/A is instrumented with beta, leverage ratio, log of total assets, R&D to sales ratio, book-to-market value ratio, dividend dummy, and rating dummies for A, BBB, and BB.

Table 6

Additional Regressions of Swap Positions on Exposures

	2000		2002	
	(1)	**(2)**	**(3)**	**(4)**
Const.	-0.00 (0.01)	-0.00 (0.01)	0.02 * (0.01)	-0.01 (0.01)
(FLD/A)*Small	-0.45 ** (0.03)	-0.45 ** (0.03)	-0.56 ** (0.03)	-0.49 ** (0.03)
(FLD/A)*Med	-0.42 ** (0.04)	-0.45 ** (0.04)	-0.34 ** (0.04)	-0.38 ** (0.04)
(FLD/A)*Large	-0.06 (0.06)	-0.04 (0.08)	-0.24 ** (0.08)	-0.24 * (0.09)
(FXD/A)*Small		-0.06 (0.04)		0.24 ** (0.03)
(FXD/A)*Med		0.04 (0.05)		0.23 ** (0.04)
(FXD/A)*Large		-0.03 (0.03)		0.16 ** (0.04)
Interest Rate Beta	0.01 (0.01)	0.01 (0.01)	0.01 * (0.01)	0.01 * (0.01)
Nobs	390	390	483	483
Adj-R^2	0.44	0.45	0.49	0.54

* denotes significant for p-value of 0.05.
** denotes significant for p-value of 0.01.
The dependant variable is the notional value of pay-floating interest rate (IR) swaps minus the notional value of pay-fixed IR swaps, caps and collars, as a percent of total assets.

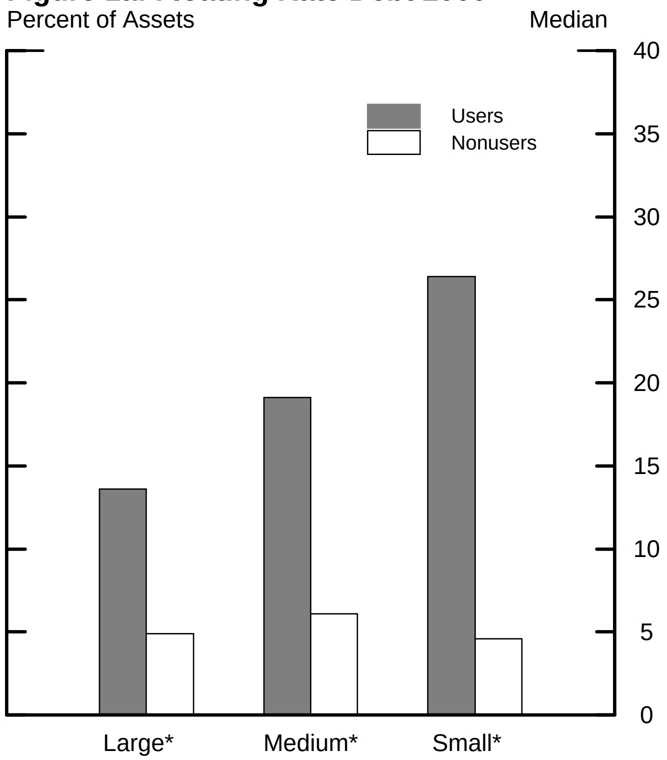
Table 7

Regressions of Changes in Swap Positions on Exposures

	(1)	**(2)**	**(3)**
Const.	0.01 **	0.02 **	0.00
	(0.01)	(0.00)	(0.01)
Δ(FLD/A)	-0.18 **		
	(0.03)		
Δ(FLD/A) * Small		-0.01	-0.37 **
		(0.04)	(0.07)
Δ(FLD/A) * Mid		-0.26 **	-0.23 **
		(0.06)	(0.08)
Δ(FLD/A) * Large		-0.26 **	-0.30
		(0.07)	(0.17)
Δ(FXD/A)	-0.06		
	(0.04)		
Nobs	294	294	227
Adj-R2	0.09	0.09	0.14

* denotes significant for p-value of 0.05.
** denotes significant for p-value of 0.01.
The dependant variable is the change in the difference between the notional value of pay-floating interest rate (IR) swaps minus the notional value of pay-fixed IR swaps, caps and collars, as a percent of total assets.

Figure 1a: Floating Rate Debt 2000



* Large firms have total assets from $5 billion. Medium firms have assets from $1 billion to $5 billion. Small firms have assets less than $1 billion.

Figure 1b: Floating Rate Debt 2000

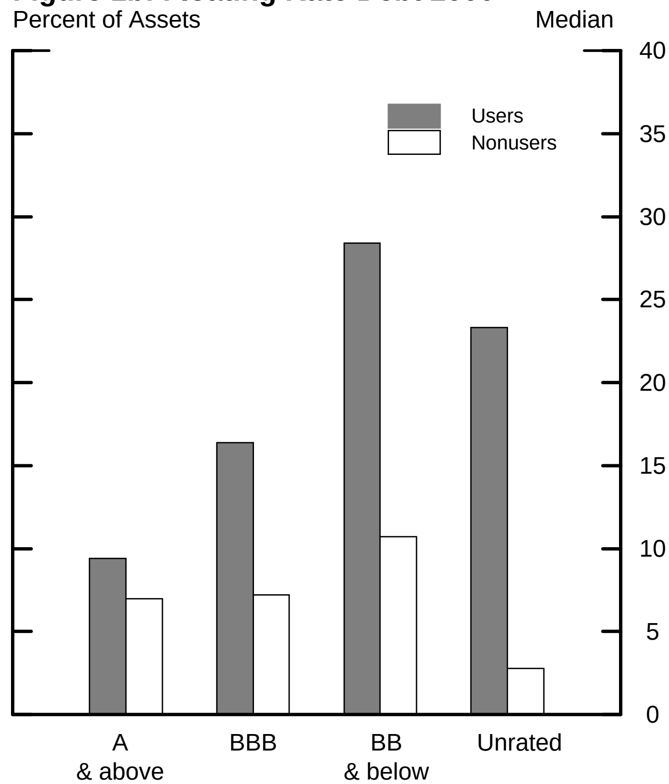
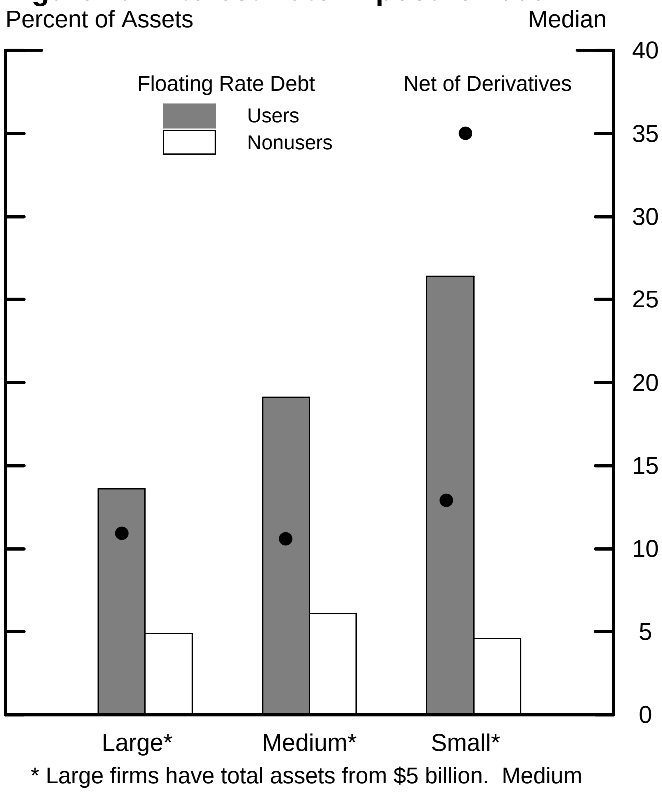


Figure 2a: Interest Rate Exposure 2000



* Large firms have total assets from $5 billion. Medium firms have assets from $1 billion to $5 billion. Small firms have assets less than $1 billion.

Figure 2b: Interest Rate Exposure 2000

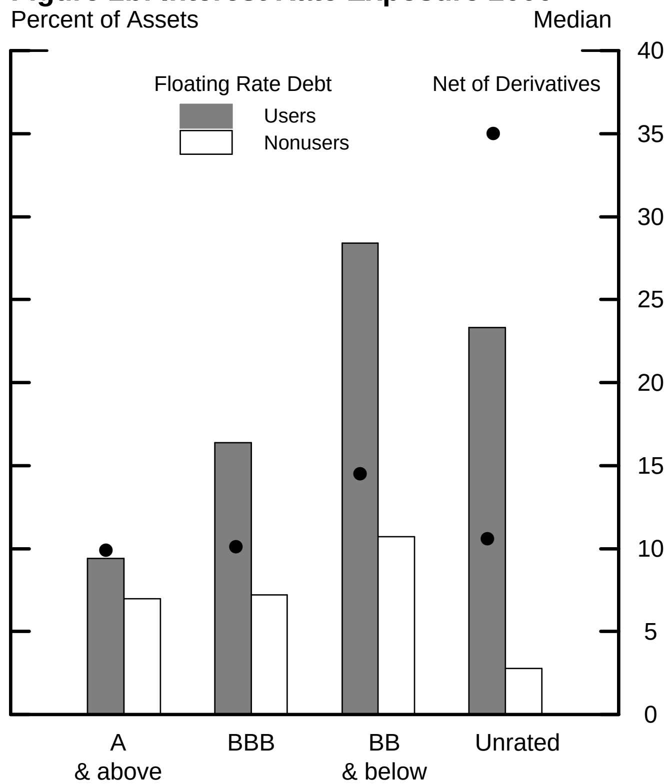
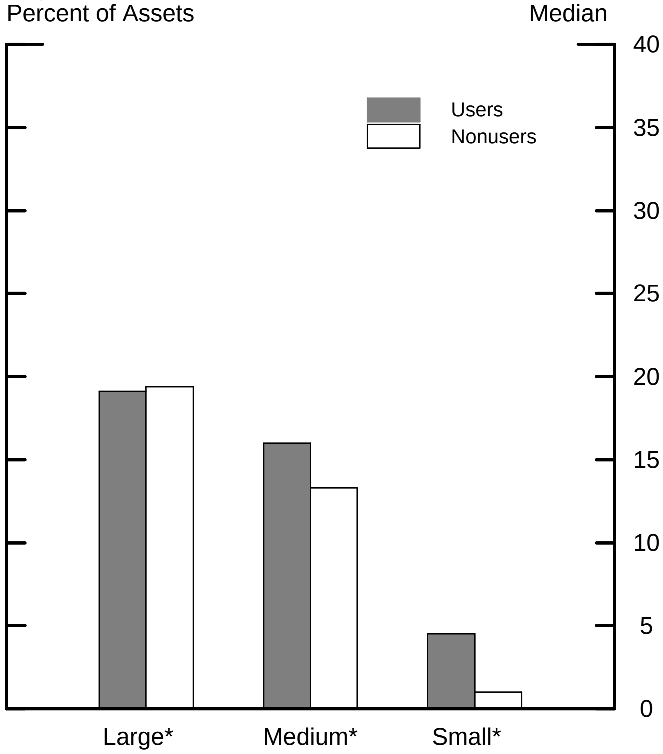


Figure 3a: Fixed Rate Debt 2000



* Large firms have total assets from $5 billion. Medium firms have assets from $1 billion to $5 billion. Small firms have assets less than $1 billion.

Figure 3b: Fixed Rate Debt 2000

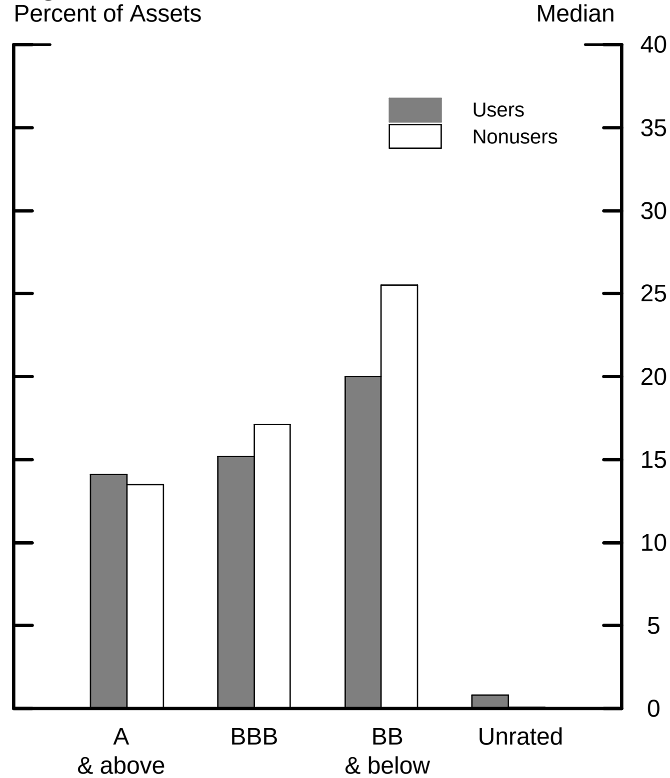
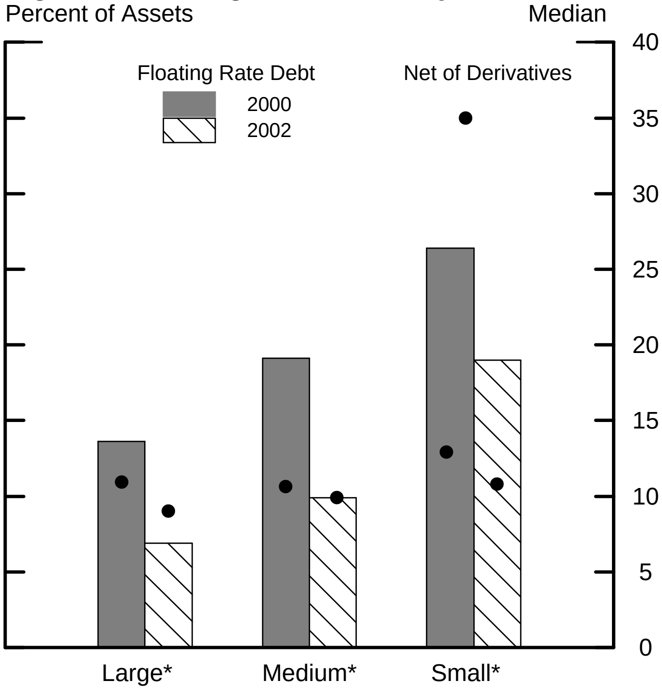


Figure 4a: Change in Users' Exposure



* Large firms have total assets from $5 billion. Medium firms have assets from $1 billion to $5 billion. Small firms have assets less than $1 billion.

Figure 4b: Change in Users' Exposure