Table 2 are consistent with our hypothesis that a supplier with a more concentrated customer base has a higher cost of equity.

In untabulated analyses, we rerun the regressions in column 4-6 of Table 2 using the implied cost of equity calculated by taking the median of the four individual estimates as the dependent variable. The results are quantitatively and qualitatively similar to those when the mean of the four individual cost of equity estimates is the dependent variable. We also rerun the same regressions for each of the four individual cost of equity estimates separately. The results show a positive relation between all three customer concentration measures and each of the cost of equity estimates. Yet, while we find a positive and statistically significant relation in all models using the cost of equity estimates following Easton (2004) and Ohlson and Juettner-Nauroth (2005), the positive relation is statistically insignificant in four out of six regression models using the cost of equity estimates following Claus and Thomas (2001) and Gebhardt et al. (2001).[14]

3.2. Customer Concentration and Supplier Risk

The finding of a positive relation between customer concentration and a supplier's cost of equity suggests that this risk is non-diversifiable. According to traditional asset pricing theories, customer concentration risk would have to be related to a supplier's systematic risk to be non-diversifiable and therefore priced into the supplier's cost of equity because investors can and should diversify away firm-specific risk (e.g., Lambert et al., 2007; Lintner, 1965; Sharpe, 1964). Thus, to provide further evidence on whether customer concentration risk is non-diversifiable, we next examine the relation between our three

[14] As an additional robustness check to examine the sensitivity of our findings to using alternative methods of approximating a supplier's cost of equity, we follow Barth et al. (2013) and estimate each supplier's cost of equity from firm-specific monthly time-series regressions using the three-factor model described by Fama and French (1993), as well as adding both a fourth momentum factor described by Jegadeesh and Titman (1993) and Carhart (1997) and a fifth liquidity factor described by Pástor and Stambaugh (2003). A benefit of this approach is that we can estimate the cost of equity for suppliers with and without analyst coverage. For each cost of equity estimate, we require the estimate to be positive to enter the sample, resulting in sample sizes ranging from 76,981 to 82,424 supplier-year observations. Using the same model specifications from columns 4-6 of Table 2 (excluding analyst forecast dispersion and analyst forecasted long-term growth rates as control variables), we find a positive and statistically significant relation between all three measures of customer concentration and all three estimates of a supplier's cost of equity. In terms of economic significance, a supplier that depends on at least one major customer for at least 10% of annual revenues has a cost of equity that is 21.6 to 44.2 basis points higher.

measures of customer concentration and measures of a supplier's systematic risk. Specifically, we regress yearly measures of a supplier's equity beta on our customer concentration measures. We calculate supplier equity betas using both value-weighted and equally-weighted daily market returns over the supplier's fiscal year, correcting both measures for nonsynchronous trading following Scholes and Williams (1977).[15]

The results in columns 1-3 of Table 3 show a positive relation between customer concentration and a supplier's value-weighted beta across all three measures of customer concentration. The coefficient estimate on *Major Customer* in column 1 implies that a supplier with at least one major customer has a value-weighted beta that is 0.069 higher. Given that the sample mean of the value-weighted beta is 1.11, this finding translates into a beta that is 6.2% (=0.069/1.11) higher relative to the sample mean. Columns 4-6 show a statistically and economically similar positive relation between customer concentration and a supplier's equally-weighted beta. For instance, the coefficient estimates in column 4 imply that a supplier with at least one major customer has an equally-weighted equity beta that is 0.096 higher. This finding translates into an equally-weighted beta that is 7.6% (=0.096/1.27) higher relative to its sample mean of 1.27. Overall, the results in Table 3 are consistent with a concentrated customer base increasing a supplier's systematic risk.[16]

The findings in Table 3 suggest that the positive relation between customer concentration and a supplier's cost of equity is in part due to a positive relation between customer concentration and a supplier's systematic risk. However, there is a growing strand of literature recognizing that market imperfections and investor holding biases often

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[15] We also rerun the analyses in Tables 3 and 4 and correct equity beta and idiosyncratic risk for nonsynchronous trading following Dimson (1979), using contemporaneous market returns as well as five leads and lags. Our results hold using these alternative specifications.

[16] The positive relation between customer concentration and a supplier's systematic risk can be thought of in terms of the relation between firm diversification and systematic risk. Hann et al. (2013) argue that during periods of low cash flows, a firm incurs deadweight costs, which include forgone business opportunities due to defections by stakeholders, financial distress costs, external financing costs, etc. The expected value of these deadweight costs tends to be larger during worse economic times, resulting in losses that are partly countercyclical and increase a firm's systematic risk. To the extent that business segment diversification coinsures against low cash flows in any individual segment, diversification lowers these expected deadweight costs. Similarly, to the degree that a diversified customer base coinsures against losses from individual customers, a more diversified customer base should lower expected countercyclical deadweight costs and therefore lower systematic risk.

prevent investors from diversifying their portfolios, resulting in the pricing of firm-specific risk (e.g., Fu, 2009; Malkiel and Xu, 2004; Spiegel and Wang, 2005).[17] Further, Taylor and Verrecchia (2014) show that both idiosyncratic and systematic risk factors can be priced in a rational expectations model that allows individual investors to delegate their trades to a privately informed financial intermediary, such as an institutional investor. To provide insight on whether the pricing effect of customer concentration could stem from firm-specific risk, we next examine the relation between our measures of customer concentration and a supplier's idiosyncratic risk. We define *Idiosyncratic Risk* the same as in Table 2, which is corrected for nonsynchronous trading following Scholes and Williams (1977).

Columns 1-3 of Table 4 show that, across all three measures of customer concentration, there is a positive and statistically significant relation between customer concentration and a supplier's idiosyncratic risk.[18] This finding is consistent with empirical evidence documented in Albuquerque et al. (2014). In terms of economic significance, the coefficient estimates in column 1 imply that a supplier with at least one major customer has annualized idiosyncratic risk that is 0.029 higher. Given that the sample mean of idiosyncratic risk is 41.1%, this finding translates into idiosyncratic risk that is 7.1% (=0.029/0.411) higher relative to the sample mean.[19]

In sum, the results in Tables 3 and 4 show that suppliers with a more concentrated

[17] For example, market imperfections and investor holding biases that prevent investors from diversifying their portfolios include transaction costs, institutional constraints, incomplete information, and preferences for local stocks (e.g., Coval and Moskowitz, 1999; Ivković and Weisbenner, 2005).

[18] We note that, inconsistent with our prediction, the results in Tables 3 and 4 show a negative correlation between book leverage and both systematic and idiosyncratic risk. However, the negative relation is sensitive to the set of control variables included in the models but does not appear to have a material effect on our findings and conclusions. In particular, the positive relation between customer concentration and both systematic and idiosyncratic risk is robust to making the following modifications to our regressions: (1) excluding all control variables, (2) excluding book leverage, (3) replacing book leverage with market leverage, (4) replacing book leverage with market leverage and excluding the book-to-market ratio, and (5) controlling for size with the book value of assets instead of the market value of equity.

[19] We also examine the sensitivity of our findings in Tables 3 and 4 to not restricting the sample to supplier-years with analyst coverage. Specifically, we re-estimate the models in Tables 3 and 4 for all Compustat industrial firms over the 1981-2011 period, resulting in a sample size of 113,524 supplier-year observations. Using the same model specifications from Tables 3 and 4 (excluding analyst forecast dispersion and forecasted long-term growth rates as control variables), we find a positive and statistically significant relation between all three measures of customer concentration and all measures of systematic and idiosyncratic risk. Further, the economic effect of customer concentration on a supplier's risk from this analysis is similar to that reported in Tables 3 and 4.

customer base have higher systematic and idiosyncratic risk. These findings suggest that the positive relation between customer concentration and a supplier's cost of equity could be driven by systematic or idiosyncratic risk. However, similar to other studies (e.g., Ashbaugh-Skaife et al., 2009; Chen, Chen, and Wei, 2011), we control for both types of risk in our cost of equity regressions. Thus, the customer concentration risk pricing that we document is over and above our measures of systematic and idiosyncratic risk, which could be attributed to measurement error in these variables. In particular, this measurement error arises because investors should price forward-looking risk and it is implausible if not impossible to perfectly measure these types of risks using historical return data (Lambert et al., 2007).

3.3. Cross-Sectional Tests of Customer Concentration and the Cost of Equity Capital

We next conduct cross-sectional tests that exploit settings that provide variation in the magnitude of risk in customer-supplier relationships. Specifically, we examine whether the effect of customer concentration on a supplier's cost of equity varies predictability with: (1) the probability that a customer will default or declare bankruptcy, (2) the likelihood that a customer will switch to a different supplier, (3) the extent of a supplier's losses if a major customer goes bankrupt, and (4) the extent to which a supplier can diversify away customer concentration risk. In addition to shedding light on the economic mechanisms behind our main results, these tests further alleviate endogeneity concerns and in particular, the concern of an omitted correlated variable. For an omitted variable to explain our results, it would also have to explain and be consistent with all of our cross-sectional findings.

3.3.1. The Effect of Customer Default Probability

One of the primary concerns with depending on sales to major customers is the greater risk of significant cash flow losses in the event that any of these customers default or declare bankruptcy. Consistent with this notion, suppliers experience negative abnormal stock returns to the announcement that a major customer declares bankruptcy (Hertzel et al., 2008; Kolay et al., 2015). Thus, the positive relation between customer concentration and a supplier's cost of equity should be more pronounced if one of its major customers has a higher likelihood of defaulting or declaring bankruptcy.

To test this prediction, we use three measures of default probability to capture the likelihood that a major customer will default or declare bankruptcy. Our first measure follows Bharath and Shumway (2008) and is an expected default probability based on the Merton (1974) bond pricing model. Our second measure is based on Shumway's (2001) probability of bankruptcy that uses both accounting ratios and market-driven variables to predict this probability.[20] Following Kim et al. (2011), our last measure uses the first principal component from Altman's (1968) Z-score, Ohlson's (1980) O-score, and Shumway's (2001) probability of bankruptcy instead of using these default measures individually.[21]

To calculate the default measures for each customer, we first use a matching algorithm similar to Fee and Thomas (2004) to match reported customer names in the Compustat segment file to their identifiers on CRSP. To link customer names with full company data, we use the following procedure. First, we use an algorithm that determines the likelihood that the reported customer name matches the historical company name listed on CRSP by comparing the number and order of the letters of the two names (SAS SPEDIS function). We then identify the four company names from CRSP that are most likely to match the reported customer name. In cases when visual inspection determines an almost certain, distinct match, we link the name with the CRSP name and permanent identification number.

For those reported customer names that still lack matches using the above method,

[20] Shumway's (2001) probability of bankruptcy = $e^w/(1+e^w)$, where w = -13.303-1.982*(net income/total assets)+3.593*(total liabilities / total assets)-0.467*log(firm's market value of equity / total market value of equity)-1.809*(excess stock return over the CRSP value-weighted index return in the past 12 months)+5.791*(idiosyncratic stock return volatility in the past twelve months). Idiosyncratic stock return volatility is the standard deviation of the residuals from regressing monthly individual stock returns over the past 12 months on the contemporaneous CRSP value-weighted market returns. We require the customer have 12 months of return data to enter the calculation.

[21] Altman's (1968) Z-score = 1.2*(working capital / total assets)+1.4*(retained earnings / total assets)+3.3*(EBIT / total assets)+0.6*(market value of equity / total liabilities)+0.999*(sales / total assets). Ohlson's (1980) O-score =-1.32-0.407*log(total assets)+6.03*(total liabilities / total assets)-1.43*(working capital / total assets)+0.076 *(current liabilities / current assets)-1.72*(1 if total liabilities > total assets, 0 otherwise)-2.37*(net income / total assets)-1.83*(operating income before depreciation / total liabilities)+0.285*(1 if net income is negative for the last two years, 0 otherwise)-0.521*((net $income_t$-net $income_{t-1}$)/(|net $income_t$|+|net $income_{t-1}$|)).

we use LexisNexis (mainly the Directory of Corporate Affiliations database in LexisNexis) to determine if the customer name corresponds to a subsidiary of a publicly-traded firm. If it is determined that the reported customer is a subsidiary of a parent company on CRSP, we match the subsidiary to the parent's permanent identification number. Lastly, we keep only suppliers that report an identifiable customer that accounts for at least 10% of the supplier's annual revenues and for which we are able to obtain Compustat data. This step reduces the sample size from 44,218 to between 5,023 and 5,685 unique supplier-years depending on which default measure is used in the regression.

A loss of any major customer can result in material financial losses, and hence, a supplier's risk of such losses due to a major customer defaulting or declaring bankruptcy is best measured by the customer with the highest likelihood of defaulting. Therefore, we use our three measures of default probability for the customer with the highest likelihood of defaulting to proxy for a supplier's risk of having a major customer default or declare bankruptcy.[22] For each of our three measures of default probability, we create an indicator variable that is set to one if the particular measure is above the sample median in a given year and zero otherwise. We then interact these indicator variables with our customer concentration measures. Note that both *Customer HHI* and *Total Major Customer Sales* are centered by subtracting their respective sample means before interacting.

The results in all six columns of Table 5 show that there is no relation between customer concentration and the cost of equity for suppliers with financially healthy customers. However, suppliers with a more concentrated customer base and a major customer with a higher default probability have a significantly higher cost of equity across both measures of customer concentration. Further, the joint significance of the customer concentration measures and the interaction terms are statistically significant in all six

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[22] Since we use a single customer's default rate for each supplier, a potential concern is that a single customer, such as Wal-Mart or Ford Motor, is overrepresented in our sample, which could limit the generalizability of our results. However, there are 1,498 to 1,613 unique suppliers and 467 to 506 unique customers in the sample depending on which default measure is used in the regression. Thus, it is unlikely that our results suffer from the overrepresentation of an individual customer. It is also important to point out that, although major customers tend to be financially healthy in the Compustat segments database, the customers in the above median probability of default group have a relatively high default probability. The average customer in this group has a default probability between the 49th and 65th percentile of all firms in Compustat.

models. Columns 1 and 2 show the results using Bharath and Shumway's (2008) measure of customer default probability. Since this sample is restricted to only suppliers with at least one major customer, we base the calculations of the economic significance on a one standard deviation increase in *Customer HHI* of 0.120 and *Total Major Customer Sales* of 0.213. The coefficient estimates in columns 1 and 2 imply that, compared to suppliers with financially healthy customers, a one standard deviation increase in *Customer HHI* and *Total Major Customer Sales* for suppliers with a financially distressed customer results in a 20.7 (=1.721*0.120) and 21.6 (=1.015*0.213) basis point higher cost of equity, respectively.

Columns 3-4 and 5-6 show the results using Shumway's (2001) probability of default and the first principal component, respectively. The economic and statistical significance of the coefficient estimates on the interaction terms using *Customer HHI* in columns 3 and 5 are comparable to those in column 1. Specifically, a one standard deviation increase in *Customer HHI* for suppliers with a financially distressed customer results in a 20.5 (column 3) and 23.9 (column 5) basis point higher cost of equity. While still economically and statistically significant, the coefficient estimates on the interaction terms using *Total Major Customer Sales* in columns 4 and 6 are lower compared to the estimates in column 2. A one standard deviation increase in *Total Major Customer Sales* for suppliers with a financially distressed customer results in a 16.0 (column 4) and 19.5 (column 6) basis point higher cost of equity. Overall, the results in Table 5 are consistent with a concentrated customer base having a larger effect on the cost of equity for suppliers that have a major customer that is more likely to default or declare bankruptcy.

3.3.2. The Effect of Customer Switching Costs

Another risk of having a concentrated customer base is that a major customer can switch suppliers, which can result in material financial losses. Therefore, we next consider whether the positive relation between customer concentration and a supplier's cost of equity varies when a major customer faces lower barriers to switching suppliers. Prior work shows that when a supplier has a lower share of industry sales, there are more alternative suppliers that customers can purchase from, which lowers switching costs and increases the likelihood that customers switch suppliers (Hui et al., 2012; Inderst and Wey, 2007; Schumacher, 1991; Snyder, 1996). Also, a customer is less reliant on a supplier and faces lower switching costs if the supplier provides the customer with a smaller portion of its total inputs. Thus, the positive relation between customer concentration and a supplier's cost of equity should be more pronounced when the supplier has a smaller industry market share and when a customer's purchases from a supplier are low relative to its total purchases.[23]

To test our prediction, we first create two measures of supplier sales-based industry market share. The first measure of supplier market share is the fraction of the supplier's total 2-digit SIC industry sales captured by the supplier. Since 2-digit SIC industries can be coarse industry classifications, suppliers in the same 2-digit industry may not be competing for the same customers. Hence, we compute our second measure of supplier market share using the fraction of the supplier's total 3-digit SIC industry sales captured by the supplier. To capture a customer's dependence on a supplier for inputs, we divide supplier sales to the customer by the customer's cost of goods sold (e.g., Banerjee et al., 2008; Fee and Thomas, 2004; Hui et al., 2012). For each of the three measures, we create an indicator variable that is set to one if a specific measure is below the sample median in a given year and zero otherwise. These indicator variables capture situations when customers have lower switching costs. We then interact the three variables with our customer concentration measures.

[23] A third potential measure of customer switching costs is the length of time that the customer has been purchasing from a particular supplier (e.g., Brown et al., 2009). We use several measures to capture the length of each customer-supplier relationship, but we do not find that relationship length has an effect on the positive relation between customer concentration and a supplier's cost of equity. This insignificant finding, while surprising, may be due to a few reasons. First, while a longer relationship length may imply that the customer has greater switching costs due to the supplier and customer making relationship-specific investments (RSIs), a supplier that has made RSIs may face greater risk because there are fewer alternative outlets for its products (e.g., Brown et al., 2009). We elaborate on the effect of RSIs on the positive relation between customer concentration and a supplier's cost of equity in Section 3.4. A second concern is related to potential truncation biases associated with our measures. In particular, because firms did not have to disclose sales to a major customer before 1976, customer-supplier relationship lengths are mechanically shorter in the earlier years in our sample. Similarly, suppliers that have recently become publicly traded will have mechanically shorter relationship lengths because they have only a few years of public filings.

The results in all eight columns of Table 6 show that customer concentration is not statistically related to a supplier's cost of equity when major customers face above median switching costs. However, suppliers with a more concentrated customer base and a major customer that faces below median switching costs have a significantly higher cost of equity across all three measures of customer concentration. In addition, the joint significance of the customer concentration measures and the interaction terms are statistically significant in all eight models. Columns 1-3 and 4-6 show the results using supplier market share based on 2-digit and 3-digit SIC industries, respectively. The coefficient estimates in columns 1 and 4 suggest that, relative to suppliers with major customers that face higher switching costs, suppliers with at least one major customer that faces lower switching costs have a 29.0 to 31.0 basis point higher cost of equity. Finally, columns 7 and 8 document that a supplier's cost of equity is greater when the supplier provides a smaller percentage of a customer's total inputs. Overall, the findings in Table 6 suggest that a concentrated customer base is a riskier business strategy when customers can switch suppliers at a relatively low cost.

3.3.3. The Effect of Trade Credit and Diversification

A supplier also faces the risk that if a customer goes bankrupt, the supplier will have financial losses not only from the loss of future sales but also from unpaid customer invoices. Consistent with this assertion, Jorion and Zhang (2009) find that suppliers offering customers trade credit experience larger negative abnormal stock returns around the announcement of a customer filing for Chapter 11 bankruptcy. Thus, the positive relation between customer concentration and a supplier's cost of equity should be more pronounced for suppliers that offer more trade credit to their customers. To test this prediction, we create an indicator variable that is set to one if a supplier's ratio of accounts receivable to book assets is greater than the sample median in a given year and zero otherwise. We then interact this variable with our customer concentration measures.

Columns 1-3 of Table 7 show that there is not a significant relation between customer concentration and the cost of equity for suppliers that extend little trade credit to customers. However, across all three measures of customer concentration, suppliers with a more concentrated customer base and more uncollected invoices have a significantly higher cost of equity. The coefficient estimates in column 1 imply that suppliers with a major customer and above median accounts receivable balances have a 42.4 basis point higher cost of equity compared to suppliers with a major customer and below median accounts receivable balances. Further, the joint significance of the customer concentration measures and the interaction terms are statistically significant in all three models. Overall, these findings are consistent with a concentrated customer base having a larger effect on the cost of equity for suppliers that also face the risk of being unable to collect outstanding invoices from bankrupt customers.

A supplier that loses a major customer and operates in only one business segment is also less able to offset a loss in sales. This prediction follows from literature suggesting that revenues from multiple business segments can coinsure against the loss of sales in another segment (Hann et al., 2013). In addition, to the extent that the loss of a major customer can signal inherent problems about the supplier's products to its remaining customers, suppliers with only one product line face a higher risk of compounded losses. Thus, the positive relation between customer concentration and a supplier's cost of equity should be more pronounced when suppliers operate in a single business segment. To test this prediction, we create an indicator variable that is set to one if a supplier operates in only one business segment and zero otherwise. We then interact this variable with our customer concentration measures.

Columns 4-6 of Table 7 show that there is not a significant relation between customer concentration and the cost of equity for suppliers that operate in more than one business segment. However, across all three measures of customer concentration, suppliers with a more concentrated customer base that operate in a single business segment have a significantly higher cost of equity. The coefficient estimates in column 4 imply that suppliers with a major customer and only one business segment have a 28.6 basis point higher cost of equity relative to suppliers with a major customer and multiple business segments. Further, the joint significance of the customer concentration measures and the interaction terms are statistically significant in all three models. In sum, these findings suggest that the risks associated with having a concentrated customer base and its effect on a supplier's cost of equity is larger for suppliers with a non-diversified revenue stream.

3.4. The Role of Relationship-Specific Investments

When a supplier sells a large portion of its annual revenues to an individual customer, these relationships often involve unique or specialized products that offer little value outside of these relationships (Titman and Wessels, 1988). In this section, we therefore examine how the positive relation between customer concentration and a supplier's cost of equity varies with relationship-specific investments (RSIs) made by customers and suppliers. In our context, it is unclear how these RSIs impact the risk of having a concentrated customer base. On one hand, a supplier that has made RSIs faces a larger risk of material financial losses if it is unable to redeploy assets after the loss of a major customer. In addition, suppliers that invest in relationship-specific assets are more likely subject to ex-post opportunistic renegotiations by customers, which can also increase risk (Williamson, 1979). Thus, this reasoning leads to the prediction that the positive relation between customer concentration and a supplier's cost of equity should be more pronounced when customer-supplier relationships involve more RSIs.

On the other hand, relationships between suppliers and their major customers are often bilateral (Banerjee et al., 2008). When suppliers make RSIs, major customers may also invest in these relationships, such as investing in training suppliers or modifying production processes (Cen et al., 2013). These investments made by the customer can increase its cost of switching suppliers, which would reduce the risk of a concentrated customer base. Thus, this notion leads to the prediction that the positive relation between customer concentration and a supplier's cost of equity should be less pronounced when customer-supplier relationships involve more RSIs.

To test these two competing predictions, we use several measures of RSIs. First, Titman and Wessels (1988) and Hui et al. (2012) capture investment in unique assets with a supplier's SG&A expenses and its advertising expenses. Thus, we capture the extent to which a supplier makes RSIs using the sum of supplier SG&A and advertising expenses all scaled by book assets *(Selling Expenses)*. For our second measure, we follow Kale and Shahrur (2007) and Raman and Shahrur (2008) and capture RSIs by a supplier's R&D expenditures scaled by book assets *(R&D Expenditures)*. As an alternative to R&D expenditures, we use NBER patent data to calculate each supplier's number of patents scaled by book assets *(Patents)*, which is an output from R&D expenditures. For each of these measures of RSIs, we create an indicator variable that is set to one if the particular measure is above the sample median in a given year and zero otherwise. Lastly, following Banerjee et al. (2008), we limit the sample to only manufacturing firms (SIC 2000-3999) and proxy for RSIs with an indicator variable (*Durable Goods)* that is set to one for firms in durable goods industries (SIC 3400-3999). We then interact these indicator variables with our customer concentration measures.

In untabulated results, we find evidence consistent with RSIs simultaneously increasing and decreasing the risks associated with having a concentrated customer base. Specifically, in five out of six regressions, we find a positive and statistically significant relation between our measures of customer concentration and the cost of equity for suppliers when RSIs are captured with *Selling Expenses* and *Durable Goods*. However, in four out of six regressions, we find a negative and statistically significant relation between our measures of customer concentration and the cost of equity for suppliers that make larger RSIs, as measured by *R&D Expenditures* and *Patents*. Overall, the results are highly sensitive to the measure used to capture RSIs and therefore provide inconclusive evidence on how RSIs impact the risk associated with having a concentrated customer base.

3.5. Government Customers and the Cost of Equity Capital

Our analysis so far has focused on the risk of having a concentrated base of corporate customers. However, U.S. federal government spending is also significant, accounting for 23.2% of GDP in 2011.[24] Importantly, the federal government is unlikely to declare bankruptcy, and federal procurement contracts are typically longer-term and explicit, which lowers the likelihood that the government will switch to a different supplier. Also, a non-trivial fraction of these contracts use cost-plus pricing, which assigns more operational risk to the government than the supplier (e.g., Berrios, 2006; Reichelstein, 1992).[25] Consequently, we expect that a supplier that depends on the federal government for a large portion of annual revenues will be less risky and therefore have a lower cost of equity.[26]

To test this prediction, we use the Compustat segment files to identify suppliers that report a federal government customer as accounting for at least 10% of total annual revenues. Examples of such government customers include branches of the military, Medicare, and Medicaid. We then create three measures to capture federal government customer concentration that are defined similarly to our corporate customer concentration measures. Specifically, *Gov't Major Customer* is an indicator variable set to one if a supplier discloses at least one federal government customer that accounts for 10% or more of its total sales, *Gov't Customer HHI* is the federal government customer sales-based Herfindahl-Hirschman Index, and *Gov't Total Major Customer Sales* is the fraction of a supplier's total sales to all federal government customers that account for at least 10% of total sales. In our sample, 7.6% of suppliers have at least one major federal government customer that accounts for 10% or more of their annual revenues. For these suppliers, sales to all federal government customers account for 47.8% of annual revenues on average.[27]

[24] We obtain U.S. government spending statistics from http://www.usgovernmentspending.com. The database is created by collecting spending totals from federal, state, and local agencies. Most data are collected from the Office of Management and Budget or the United States Census Bureau.

[25] We obtain U.S. government spending data for years 2003-2014 and find that approximately 31% of all federal contract award dollars have cost-plus pricing terms.

[26] In this test, we focus on sales to the federal government because the federal government is unlikely to default. In contrast, there is a higher likelihood that state and local governments will default, as evidenced by bankruptcy filings in cities such as Detroit.

[27] In our sample, 0.56% of suppliers also disclose a state or local government agency as accounting for at least 10% of sales. For these suppliers, sales to all state and local government customers account for 30.6% of annual revenues on average. As a robustness check, we redefine our government customer concentration measures to

The results in Table 8 show a negative relation between all three measures of government customer concentration and a supplier's cost of equity.[28] The coefficient estimate on *Gov't Major Customer* in column 1 implies that a supplier with a federal government customer accounting for at least 10% of annual revenues has a 19.1 basis point lower cost of equity. In sum, the results in Table 8 are consistent with the prediction that suppliers with a more concentrated base of safer government customers realize benefits in the form of a lower cost of equity.

3.6. Customer Concentration and the Cost of Debt Capital

Our arguments for whether a concentrated customer base increases a supplier's business risk also generate the empirical prediction of a positive relation between customer concentration and a supplier's cost of debt. To test this prediction, we investigate the effect of a concentrated base of corporate customers on two measures of a supplier's borrowing costs: (1) the cost of bank debt and (2) the cost of public debt. Since bank debt is the principal source of debt financing used by most firms (Faulkender and Petersen, 2006), we first focus our analysis on the cost of bank debt. This measure has the advantage of data availability for a larger sample compared to our second measure. We obtain U.S.-originated and U.S. dollar-denominated loan data from Dealscan for our sample of suppliers. Since Dealscan begins tracking loans for most firms starting in 1987, we use the sample period from 1987 to 2011.

Panel A of Table 9 presents the results relating customer concentration to a supplier's bank loan spreads. The dependent variable in columns 1-6 is the natural logarithm of a supplier's credit spreads, defined as the spread between its interest rate on a bank loan and LIBOR. The credit spread is measured as the all-in-spread drawn in Dealscan, defined as the amount the borrower pays in basis points over LIBOR for each

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include sales to state and local governments. Our results remain quantitatively and qualitatively similar.

[28] In untabulated analyses, we also examine the relation between government customer concentration and a supplier's systematic and idiosyncratic risk. We rerun the same regressions in Tables 3 and 4 and include our measures of government customer concentration as additional regressors. We find a negative and statistically significant relation between all three measures of government customer concentration and a supplier's systematic and idiosyncratic risk. Overall, the results from these additional analyses support the notion that dependence on a major government customer for a large portion of revenues lowers a supplier's risk.

dollar drawn down (including annual fees paid to the bank group). In columns 1-3, we use a set of control variables similar to Valta (2012). Specifically, we control for the natural logarithm of book assets, the market-to-book ratio, return on assets, the proportion of assets that are fixed, book leverage, and Altman's Z-score. In columns 4-6, we also control for the natural logarithm of the loan maturity (in months), the natural logarithm of the loan amount (in millions), and loan type fixed effects. In all six columns, we continue to include industry × year fixed effects.

In all model specifications, the results show a positive relation between customer concentration and a supplier's cost of bank debt. In terms of economic significance, the coefficient estimates on *Major Customer* in columns 1 and 4 imply that a supplier that depends on at least one major corporate customer for 10% or more of its annual revenues has borrowing costs that are approximately 6.0% and 5.0% higher, respectively.[29]

Next, we examine the relation between customer concentration and the cost of public debt. We obtain U.S. originated, U.S. dollar-denominated, and non-convertible public bond issuance data from Thomson-Reuters SDC Spectrum Global New Issues database for our sample of suppliers over the 1981 to 2011 period. To create a cleaner sample of public corporate bonds, we delete floating rate, private placement, asset backed, and perpetual bonds. We also remove unit issues that are a combination of securities, such as common stock and warrants, from our sample.

Panel B of Table 9 presents the results relating customer concentration to a supplier's public debt spreads. The dependent variable in columns 1-6 of Panel B is the natural logarithm of the amount the borrower pays over the comparable maturity treasury security in basis points. The regressions are analogous to those in Panel A. In all model specifications, the results show a positive relation between customer concentration and a supplier's cost of public debt. For instance, the coefficient estimates on *Major Customer* in columns 1 and 4 imply that a supplier that depends on at least one major corporate

[29] The following example illustrates how we compute the economic significance of coefficient estimates in Table 9. The increase in *Log Loan Spread* of 0.058 log points corresponds to an increase in loan spreads of $e^{(0.058)}$-1 = 6.0 percentage points.

customer for 10% or more of its annual revenues has borrowing costs that are approximately 9.9% and 7.0% higher, respectively.

Overall, the findings in Table 9 provide evidence that suppliers with a concentrated customer base have not only a higher cost of equity but also a higher cost of debt.[30,31] These findings are also consistent with those documented in Campello and Gao (2014) who test the effect of the exposure to large customers on a supplier's creditworthiness. The authors show that suppliers with a concentrated customer base have loans with higher interest rate spreads, more restrictive covenants, and shorter maturities.

4. Addressing Potential Endogeneity

4.1. Propensity Score Matched Sample Analysis

A potential endogeneity concern is that our models suffer from an omitted variable that is correlated with both customer concentration and a supplier's cost of equity (Kennedy, 2008). In particular, our measures of customer concentration could be picking up nonlinear effects if the linear controls used throughout our models do not adequately account for differences between suppliers with a concentrated customer base and those with a diverse customer base. Therefore, we use a propensity score matched sample to correct for any endogenous selection on observed variables (Dehejia and Wahba, 2002; Rosenbaum and Rubin, 1983).

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[30] In untabulated analyses, we also examine the cross-sectional effects described in Tables 5-7 on the positive relation between customer concentration and a supplier's cost of debt. Overall, we do not find cross-sectional variation in this relation for the majority of our model specifications. While the exact reason why we do not find the same cross-sectional effects for our cost of debt tests is unclear, data limitations such as smaller sample sizes is one possible explanation.

[31] In untabulated analyses, we also investigate whether a supplier that depends on the federal government for a large portion of its annual revenues has a lower cost of debt. Consistent with a concentrated base of federal government customers lowering a supplier's risk and using the full model specifications in columns 4-6 of Table 9, we find a negative and statistically significant relation between all three of measures of government customer concentration (from Table 8) and the spread on a supplier's public bonds. However, we document a positive and statistically significant relation between all three measures of government customer concentration and the spread on a supplier's bank loans. We conjecture that, due to the nature of banking relationships, banks are able to charge a supplier a higher interest rate and the supplier is willing to pay a higher interest expense if it can pass on the cost to the government. To test this proposition, we assume that suppliers are more likely to pass on costs to the government if the federal contracts have cost-plus pricing terms, which allow the supplier to be paid for all of its allowed expenses up to a set limit plus an additional payment to allow for a profit. Using detailed data on federal contracts from the website usaspending.gov, we find evidence consistent with our conjecture. Specifically, suppliers with more federal contracts under cost-plus pricing terms pay the highest interest rates.

Using a Conditional Logistic Regression model, we first regress the indicator variable for whether a supplier has at least one major customer on our previously used control variables and estimate the probability (i.e., the propensity score) that a supplier sells to a major customer. Column 1 in Panel A of Table 10 reports the marginal effects from this regression. Next, we match each observation when a supplier reports a customer accounting for at least 10% of its annual revenues to an observation when a supplier does not rely on sales to a major customer with the closest propensity score. We match without replacement and require the propensity scores for each matched pair to be within ±1.0% of each other.[32] The resulting sample consists of 8,926 supplier-years when a supplier is dependent on a major customer matched to 8,926 supplier-years when a supplier is not dependent on a major customer.

Following Fang et al. (2014), we perform several diagnostic tests to evaluate the successfulness of our matching procedure. If the matching procedure is successful, then we should find that: (1) the control variables in the matched sample do not explain any variation in whether suppliers have major customers, (2) the difference in the propensity scores of suppliers with and without major customers is negligible, and (3) the means of the matched variables are not statistically different for suppliers with and without major customers.

We test these predictions in three ways. First, we rerun the same model specification as in column 1 of Panel A for the matched sample and report the results in column 2. The results show that all of the control variables are statistically insignificant, and the pseudo-R^2 drops to less than 0.1%, indicating that the control variables do not explain any variation in whether a supplier has a major customer. Second, we examine the difference between the propensity scores of a supplier with and without a major customer and tabulate the results in Panel B. The mean difference is less than 0.001 and therefore trivial. Third, Panel C reports the univariate comparisons of the means of each matched

[32] We use the ±1.0% cutoff so that matched suppliers are very similar. The results are robust to using a ±0.5%, ±2.5%, or ±5.0% cutoff point.

variable between a supplier with and without a major customer. The results show that the means of the matched control variables are statistically the same across the two samples. Collectively, these diagnostic tests suggest that the matching procedure is successful.

The univariate results in Panel C also show that, for the matched sample, suppliers with a major customer have a 16.4 basis point higher cost of equity. Panel D presents the multivariate results from our base regressions in columns 4-6 of Table 2 using the matched sample. Consistent with earlier findings, the results show that a supplier with a more concentrated customer base has a higher cost of equity. Together, the results from this analysis suggest that omitted variables related to nonlinear forms of our control variables are not likely driving our findings.

4.2. Instrumental Variables Regressions

While our previous analysis helps alleviate endogeneity concerns, it is still possible that endogeneity arising from unobserved omitted variables remains. For instance, we are unable to observe: (1) whether different customer-supplier relationships are governed by implicit versus explicit contracts, and (2) the existence of managerial-specific relationships between customers and suppliers. The extent to which these factors are more prevalent among major customers and correlated with a supplier's cost of equity could bias our findings. Thus, we next examine the robustness of our main findings to controlling for endogeneity using an instrumental variables approach. This approach relies on the notion that our instrumental variables are correlated with our customer concentration measures but uncorrelated with the error terms.

Specifically, instrumental variables must satisfy two conditions to be considered valid instruments (e.g., Larcker and Rusticus, 2010; Roberts and Whited, 2013). First, the relevance condition requires that the instruments are correlated with our measures of customer concentration after controlling for the set of control variables in our main model specification. Second, the exclusion restriction requires that, conditioning on the full set of control variables, the instruments are correlated with a supplier's cost of equity only through their correlations with measures of customer concentration.

We select lagged industry averages of each customer concentration measure as our instrumental variables. Specifically, we use two-year and three-year lagged industry averages of the particular concentration measure. We calculate industry averages based on the supplier's 3-digit SIC industry and year and exclude the supplier's customer concentration from this calculation. For example, the instruments for whether a supplier has a major customer are the fraction of firms in the supplier's 3-digit SIC industry that report relying on at least one major customer two years ago and three years ago.

Average industry customer concentration should meet the relevance condition because it is a good proxy for the structure of a supplier's industry and will therefore be highly correlated with an individual supplier's customer-base structure. Further, to the extent that industry customer concentration is correlated with industry risk and a supplier's financing costs are related to industry risk, industry average concentration measures are unlikely related to the individual supplier's financing costs after controlling for the individual supplier's risk. By using lagged industry average values, it is also less likely that industry averages will be correlated with a supplier's current cost of equity because investors price future risk not historical risk. Thus, industry average customer concentration measures likely satisfy the exclusion restriction. Yet, because the industry structure of customers is likely persistent through time, these lagged values should still be related to a supplier's current customer concentration.[33]

Panel A of Table 11 presents the first-stage results that we obtain by regressing each particular customer concentration measure on our selected instrumental variables and the set of control variables used in Table 2.[34] We perform various tests that suggest that our

[33] Our use of industry averages as instrumental variables is in line with similar approaches in several papers. For example, Jin (2002) uses industry average risk measures as instruments for firm-specific risk measures. Hanlon et al. (2003) use industry average employee stock option (ESO) grant values as instruments for firm-level ESO grant values. Shi (2003) uses industry average R&D as an instrument for firm-specific R&D. Last, Dass et al. (2014) use industry average values of relationship-specific investments as instruments for supplier relationship-specific investments with customers.

[34] We exclude industry × year fixed effects from this test. In our previous analyses, we included industry-year fixed effects to control for potential omitted variables at the industry-year level. However, if our selected instruments pass all the tests needed to be considered a valid instrument, this instrumental variables approach

selected sets of instrumental variables are valid. Specifically, the Wu-Hausman test rejects the null hypothesis that our customer concentration measures are exogenous by themselves. The high F-statistic and partial R^2 of our instruments imply that our results do not suffer from the problem of weak instruments. Lastly, using the Sargan overidentification test, we are unable to reject the null hypothesis that our selected instruments are uncorrelated with the error term, implying that the instruments are exogenous with respect to a supplier's cost of equity. The second-stage results in Panel B show a positive relation between customer concentration and a supplier's cost of equity across all three measures of customer concentration. Thus, to the extent that our instruments are valid, the results in Table 11 suggest that greater customer concentration causally increases a supplier's cost of equity.

5. Conclusion

A supplier that is dependent on a major customer faces the risk that this customer will go bankrupt, switch suppliers, move production in-house, and be unable to pay outstanding invoices once bankrupt. While prior evidence suggests that a concentrated customer base results in predictably greater risk, whether this risk is priced into a supplier's cost of equity is unclear. Consistent with customer concentration increasing a supplier's risk, we find a positive relation between customer concentration and a supplier's cost of equity. This finding is robust to accounting for endogeneity concerns using a propensity score matched sample and instrumental variables. To the extent that these additional analyses alleviate endogeneity concerns, our results can be interpreted as greater customer concentration causally increasing a supplier's cost of equity.

We also find cross-sectional variation in settings where the risk associated with having a concentrated customer base is greater. Specifically, the positive relation between customer concentration and a supplier's cost of equity is more pronounced for a supplier with: (1) a major customer that is more likely to default or declare bankruptcy, (2) a major

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corrects for all omitted variables. Therefore, the inclusion of industry × year fixed effects is not needed.

customer that has fewer barriers to switching to a different supplier, (3) greater uncollectible outstanding invoices if a major customer defaults, and (4) a non-diversified revenue stream. We also provide evidence that a supplier that relies on relatively more stable federal government customers for a significant portion of revenues has a lower cost of equity. Lastly, we find that a supplier with a concentrated corporate customer base has not only a higher cost of equity but also a higher cost of bank and public debt.

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Appendix A. Estimation of the Implied Cost of Equity Capital

We follow previous research in the cost of equity capital literature by outlining the different methodologies of estimating the cost of equity (Chen, Chen, and Wei, 2011; Dhaliwal et al., 2006). To ease the discussion, we first define the variables used in the following three models.

P_t^*	=	Implied market price of a firm's common stock at time t. We use the price in June following the latest fiscal year-end to compute P_t^*.
B_t	=	Book value of equity from the most recent available financial statements at time t.
FEPS_{t+i}	=	Median forecasted earnings per share (EPS) from IBES or derived EPS forecasts for the next i^{th} year at time t.
POUT	=	Forecasted dividends payout ratio. We use the ratio of the indicated annual dividends from IBES and FEPS_{t+1} to measure the forecasted payout ratio. If FEPS_{t+1} is negative, we assume a return on assets of 6% to calculate earnings. POUT is winsorized to be within 0 and 1.

1. Gebhardt, Lee, and Swaminathan (2001)

$$P_t^* = B_t + \sum_{i=1}^{T-1} \frac{[\text{FROE}_{t+i} - R_{\text{GLS}}] \times B_{t+i-1}}{(1+R_{\text{GLS}})^{i}} + \frac{[\text{FROE}_{t+T} - R_{\text{GLS}}] \times B_{t+T-1}}{(1+R_{\text{GLS}})^{T-1} R_{\text{GLS}}}. \quad \text{(A-1)}$$

We use IBES analysts' forecasts to proxy for the market expectation of the firm's earnings for the next 3 years. Thereafter, we measure expectations for market earnings by assuming that the future return on equity (FROE) declines linearly to an equilibrium return on equity (ROE) from the 4^{th} year to the T^{th} year. This equilibrium ROE is measured by a historical, 10-year, industry-specific median ROE. The ROE is calculated as income available for common shareholders (Compustat data item IBC) scaled by the lagged total book value of equity (Compustat data item CEQ). We classify all firms into 48 industries defined by Fama and French (1997). Following Botosan and Plumlee (2005), we involve all firms, including those with negative ROEs to compute the industry ROE. If the industry ROE is less than the risk-free rate, we set the industry ROE to be the risk-free rate (Liu et al., 2002). The future book value of equity is estimated by assuming the clean surplus relation (i.e., $B_{t+1} = B_t + \text{EPS}_{t+1} - \text{DPS}_{t+1}$). The future dividend, DPS_{t+i}, is calculated by multiplying EPS_{t+i} by POUT. We assume that T=12. We use a numerical approximation program to solve for R_{GLS} that equates the right- and left-hand sides of equation (A-1) within a difference of $0.001.

2. Claus and Thomas (2001)

$$P_t^* = B_t + \sum_{i=1}^{5} \frac{[\text{FEPS}_{t+i} - R_{\text{CT}} \times B_{t+i-1}]}{(1+R_{\text{CT}})^{i}} + \frac{[\text{FEPS}_{t+5} - R_{\text{CT}} \times B_{t+4}] \times (1+g_{lt})}{(R_{\text{CT}} - g_{lt})(1+R_{\text{CT}})^{5}}. \quad \text{(A-2)}$$

We use IBES earnings forecasts to estimate the abnormal earnings for the next 5 years. Earnings forecasts for the future 4^{th} and 5^{th} years are derived from earnings forecasts for the 3rd year and the long-term earnings growth rate. If the long-term earnings growth rate is missing from IBES, an implied earnings growth rate from EPS_{t+2} and EPS_{t+3} is used. The long-term abnormal earnings growth rate is calculated using the contemporaneous risk-free rate (the yield on 10-year Treasury bonds) minus 3%. The future book value of equity is also estimated by assuming the clean surplus relation. The future dividend, DPS_{t+i}, is calculated by multiplying EPS_{t+i} by the payout ratio, POUT. We use a numerical approximation program to solve for R_{CT} that equates the right- and left-hand sides of equation (A-2) within a difference of \$0.001.

3. Ohlson and Juettner-Nauroth (2005) and Implemented by Gode and Mohanram (2003)

(A-3)
$$R_{\mathrm{OJN}} = A + \sqrt{A^2 + \left(\frac{\mathrm{E}_t(\mathrm{EPS}_{t+1})}{P_t^*}\right)(g_2 - g_{lt})},$$

where

$$A = 0.5\left(g_{lt} + \frac{DPS_{t+1}}{P_t^*}\right),$$

and where g_2 is the average of the short-term earnings growth rate implied in EPS_{t+1} and EPS_{t+2} and the analysts' forecasted long-term growth rate. The implementation of this model requires that $EPS_{t+1} > 0$ and $EPS_{t+2} > 0$. g_{lt} is calculated using the contemporaneous risk-free rate (the yield on 10-year Treasury bonds) minus 3%.

4. The Modified PEG Ratio Model by Easton (2004)

(A-4)
$$P_t^* = \frac{\mathrm{E}_t(\mathrm{EPS}_{t+1})}{R_{\mathrm{MPEG}}} + \frac{\mathrm{E}_t(\mathrm{EPS}_{t+1})\mathrm{E}_t[g_{st} - R_{MPEG} \times (1 - \mathrm{POUT})]}{R_{MPEG}^2}$$

We use a numerical approximation program to solve for R_{MPEG} that equates the right- and left-hand sides of equation (A-4) within a difference of \$0.001. This model requires that $EPS_{t+2} \geq EPS_{t+1} > 0$.

Table 1
Summary Statistics

This table reports summary statistics for variables of interest for Compustat industrial firms (utilities and financials are excluded) from 1981 to 2011 and includes 44,218 supplier-year observations. Panels A and B present summary statistics and the correlation matrix for implied cost of equity estimates, respectively. Panel B reports the Pearson (below the diagonal) and the Spearman (above the diagonal) correlations between the estimates of the implied cost of equity, and p-values are reported in parentheses. Panel C reports summary statistics for customer concentration measures and all other variables. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Variable definitions in parentheses refer to Compustat designations where appropriate. *Cost of Equity OJN, Cost of Equity MPEG, Cost of Equity CT,* and *Cost of Equity GLS* are the implied cost of equity estimates calculated following the methodologies outlined in Ohlson and Juettner-Nauroth (2005), Easton (2004), Claus and Thomas (2001), and Gebhardt et al. (2001), respectively. *Cost of Equity Mean* is the estimated implied cost of equity calculated by taking the mean of *Cost of Equity OJN, Cost of Equity MPEG, Cost of Equity CT,* and *Cost of Equity GLS. Risk-Free Rate* is the yield on 10-year Treasury bonds. *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index calculated by summing the squares of the ratios of significant customer sales to the supplier's total sales. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. *Beta Value-Weighted* is estimated by regressing daily individual stock returns over the fiscal year on the contemporaneous CRSP value-weighted market returns, correcting for nonsynchronous trading following Scholes and Williams (1977). *Idiosyncratic Risk* is the annualized standard deviation of the residuals from regressing daily individual stock returns over the fiscal year on the contemporaneous CRSP value-weighted market returns, correcting for nonsynchronous trading following Scholes and Williams (1977). *Market Value of Equity* is the market value of equity at the end of the fiscal year *(prcc_f*csho,* in $ millions). *Book-to-Market* is book value of equity *(ceq)* divided by market value of equity. *Book Leverage* is the book value of long-term debt *(dltt)* plus book value of debt in current liabilities *(dlc)* divided by book value of assets *(at)*. *Momentum* is the stock return over the fiscal year. *Analyst Forecast Dispersion* is the natural logarithm of the standard deviation of the analysts' estimates for the next period's earnings divided by the consensus forecast for next period's earnings. *Long-Term Growth Rate* is the median analyst forecast of the long-term earnings growth rate for the supplier. *Return on Assets* is income before extraordinary items *(ib)* divided by beginning of year book value of assets *(at)*.

Panel A: Summary Statistics for Implied Cost of Equity Estimates

	Mean	Std. Dev.	P25	P50	P75
Cost of Equity OJN	12.94	3.84	10.26	12.12	14.77
Cost of Equity MPEG	12.43	4.74	9.19	11.19	14.43
Cost of Equity CT	11.58	3.82	8.95	11.05	13.65
Cost of Equity GLS	7.33	3.03	5.15	7.05	9.15
Cost of Equity Mean	11.08	3.35	8.71	10.46	12.81
Risk-Free Rate	6.64	2.65	4.93	6.10	8.28

Panel B: Correlation Matrix for Implied Cost of Equity Estimates

	Cost of Equity OJN	Cost of Equity MPEG	Cost of Equity CT	Cost of Equity GLS	Cost of Equity Mean
Cost of Equity OJN		0.863	0.725	0.627	0.947
		(0.000)	(0.000)	(0.000)	(0.000)
Cost of Equity MPEG	0.885		0.532	0.459	0.844
	(0.000)		(0.000)	(0.000)	(0.000)
Cost of Equity CT	0.702	0.526		0.682	0.833
	(0.000)	(0.000)		(0.000)	(0.000)
Cost of Equity GLS	0.655	0.473	0.683		0.778
	(0.000)	(0.000)	(0.000)		(0.000)
Cost of Equity Mean	0.952	0.866	0.828	0.782	
	(0.000)	(0.000)	(0.000)	(0.000)	

Table 1 – *(Continued)*

Panel C: Summary Statistics for Customer Concentration Measures and Control Variables

	Obs.	Mean	Std. Dev.	P25	P50	P75
Customer Concentration Measures						
Major Customer	44,218	0.26	0.44	0.00	0.00	1.00
Customer HHI	44,218	0.02	0.07	0.00	0.00	0.10
Total Major Customer Sales	44,218	0.08	0.18	0.00	0.00	0.11
Customer Concentration Measures for Suppliers with a Major Customer						
Customer HHI	11,652	0.09	0.12	0.02	0.04	0.10
Total Major Customer Sales	11,652	0.31	0.21	0.14	0.25	0.42
Control Variables						
Beta Value-Weighted	44,218	1.11	0.61	0.68	1.03	1.45
Idiosyncratic Risk	44,218	0.41	0.18	0.27	0.37	0.51
Market Value of Equity	44,218	3,771	10,064	284.8	779.6	2,433
Book-to-Market	44,218	0.51	0.33	0.27	0.43	0.66
Book Leverage	44,218	0.21	0.17	0.05	0.19	0.32
Momentum	44,218	0.23	0.58	-0.12	0.13	0.44
Analyst Forecast Dispersion	44,218	0.07	0.15	0.01	0.03	0.06
Long-Term Growth Rate	44,218	0.18	0.10	0.12	0.15	0.20
Return on Assets	44,218	0.08	0.09	0.03	0.07	0.11

Table 2
Customer Concentration and the Implied Cost of Equity

This table reports results from OLS regressions relating the implied cost of equity to customer concentration measures and control variables for Compustat industrial firms from 1981 to 2011. The dependent variable in columns 1-6 is the implied cost of equity calculated by taking the mean of the four individual estimates and is in excess of the yield on 10-year Treasury bonds. *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. All control variables are standardized to have a mean of zero and a standard deviation of one. All other variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Pred.	Dependent Variable = Cost of Equity Mean					
	Sign	(1)	(2)	(3)	(4)	(5)	(6)
Major Customer	+	0.212***			0.121***		
		(4.94)			(2.95)		
Customer HHI	+		0.932***			0.571**	
			(3.84)			(2.42)	
Total Major Customer Sales	+			0.546***			0.311***
				(4.80)			(2.81)
Beta Value-Weighted	+				0.103***	0.104***	0.104***
					(5.57)	(5.62)	(5.60)
Idiosyncratic Risk	+				0.498***	0.501***	0.498***
					(18.91)	(19.02)	(18.91)
Log(Market Value of Equity)	−	-0.685***	-0.692***	-0.684***	-0.481***	-0.483***	-0.480***
		(-26.68)	(-26.88)	(-26.50)	(-16.79)	(-16.86)	(-16.74)
Book-to-Market	+	0.549***	0.549***	0.550***	0.564***	0.564***	0.564***
		(21.44)	(21.41)	(21.47)	(22.61)	(22.60)	(22.63)
Book Leverage	+	0.549***	0.546***	0.549***	0.573***	0.571***	0.573***
		(26.03)	(25.87)	(26.01)	(28.23)	(28.16)	(28.22)
Momentum	−	-0.154***	-0.152***	-0.154***	-0.191***	-0.190***	-0.191***
		(-10.17)	(-10.06)	(-10.15)	(-12.97)	(-12.93)	(-12.96)
Analyst Forecast Dispersion	+	0.145***	0.146***	0.145***	0.091***	0.091***	0.091***
		(8.12)	(8.13)	(8.08)	(5.13)	(5.12)	(5.11)
Long-Term Growth Rate	+	0.448***	0.448***	0.446***	0.339***	0.338***	0.338***
		(19.40)	(19.39)	(19.32)	(15.10)	(15.08)	(15.06)
Return on Assets	±	-0.028	-0.027	-0.029	-0.005	-0.005	-0.006
		(-1.43)	(-1.40)	(-1.48)	(-0.26)	(-0.25)	(-0.29)
Industry × Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		44,218	44,218	44,218	44,218	44,218	44,218
Adjusted R^2		0.437	0.437	0.437	0.452	0.452	0.452

Table 3
Customer Concentration and Systematic Risk

This table reports results from OLS regressions relating market beta estimates to customer concentration measures and control variables for Compustat industrial firms from 1981 to 2011. The dependent variable in columns 1-3 is *Beta Value-Weighted,* which is estimated by regressing daily individual stock returns over the fiscal year on the contemporaneous CRSP value-weighted market returns. The dependent variable in columns 4-6 is *Beta Equally-Weighted,* which is estimated by regressing daily individual stock returns over the fiscal year on the contemporaneous CRSP equally-weighted market returns. Both beta measures are corrected for nonsynchronous trading following Scholes and Williams (1977). *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. All control variables are standardized to have a mean of zero and a standard deviation of one. All other variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Pred.	Beta Value-Weighted			Beta Equally-Weighted		
	Sign	(1)	(2)	(3)	(4)	(5)	(6)
Major Customer	+	0.069*** (6.76)			0.096*** (8.32)		
Customer HHI	+		0.211*** (4.11)			0.275*** (4.83)	
Total Major Customer Sales	+			0.155*** (5.98)			0.205*** (7.15)
Log(Market Value of Equity)	–	0.074*** (13.24)	0.071*** (12.81)	0.073*** (13.19)	-0.019*** (-3.01)	-0.023*** (-3.76)	-0.019*** (-3.13)
Book-to-Market	–	-0.015*** (-3.02)	-0.015*** (-3.11)	-0.014*** (-3.00)	-0.020*** (-3.55)	-0.020*** (-3.67)	-0.020*** (-3.54)
Book Leverage	+	-0.022*** (-4.80)	-0.023*** (-5.05)	-0.022*** (-4.83)	-0.020*** (-4.00)	-0.022*** (-4.31)	-0.021*** (-4.06)
Momentum	±	0.034*** (9.35)	0.034*** (9.51)	0.034*** (9.39)	0.048*** (11.95)	0.049*** (12.13)	0.048*** (12.01)
Analyst Forecast Dispersion	+	0.016*** (5.03)	0.016*** (5.11)	0.016*** (5.01)	0.028*** (7.69)	0.029*** (7.78)	0.028*** (7.68)
Long-Term Growth Rate	±	0.124*** (18.62)	0.125*** (18.56)	0.124*** (18.55)	0.144*** (17.99)	0.145*** (17.93)	0.144*** (17.91)
Return on Assets	±	0.004 (0.95)	0.005 (1.07)	0.004 (0.93)	-0.005 (-0.98)	-0.004 (-0.81)	-0.005 (-0.98)
Industry × Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		44,218	44,218	44,218	44,218	44,218	44,218
Adjusted R^2		0.288	0.287	0.288	0.283	0.281	0.283

Table 4
Customer Concentration and Idiosyncratic Risk

This table reports results from OLS regressions relating idiosyncratic risk estimates to customer concentration measures and control variables for Compustat industrial firms from 1981 to 2011. The dependent variable in columns 1-3 is *Idiosyncratic Risk,* which is the annualized standard deviation of the residuals from regressing daily individual stock returns over the fiscal year on the contemporaneous CRSP value-weighted market returns, corrected for nonsynchronous trading following Scholes and Williams (1977). *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. All control variables are standardized to have a mean of zero and a standard deviation of one. All other variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Pred. Sign	Dependent Variable = Idiosyncratic Risk		
		(1)	(2)	(3)
Major Customer	+	0.029***		
		(11.43)		
Customer HHI	+		0.119***	
			(8.23)	
Total Major Customer Sales	+			0.077***
				(11.46)
Log(Market Value of Equity)	−	-0.080***	-0.081***	-0.080***
		(-58.77)	(-59.37)	(-58.50)
Book-to-Market	±	-0.004***	-0.005***	-0.004***
		(-3.36)	(-3.43)	(-3.28)
Book Leverage	+	-0.007***	-0.008***	-0.007***
		(-6.47)	(-6.76)	(-6.41)
Momentum	±	0.011***	0.012***	0.012***
		(13.23)	(13.42)	(13.27)
Analyst Forecast Dispersion	+	0.019***	0.019***	0.019***
		(22.11)	(22.12)	(22.03)
Long-Term Growth Rate	+	0.032***	0.032***	0.032***
		(18.16)	(18.02)	(18.01)
Return on Assets	±	-0.009***	-0.009***	-0.009***
		(-8.05)	(-7.88)	(-8.17)
Industry × Year Fixed Effects		Yes	Yes	Yes
Observations		44,218	44,218	44,218
Adjusted R^2		0.590	0.588	0.590

Table 5
Effect of Customer Default Probability

This table reports results from OLS regressions relating the implied cost of equity to customer concentration measures and control variables for Compustat industrial firms from 1981 to 2011. Variable definitions refer to Compustat designations where appropriate. The sample is restricted to supplier-years when a supplier discloses a customer with available Compustat data. The dependent variable in columns 1-6 is the implied cost of equity calculated by taking the mean of the four individual estimates and is in excess of the yield on 10-year Treasury bonds. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. In columns 1 and 2, a customer's probability of default is calculated following the methodology in Bharath and Shumway (2008). In columns 3 and 4, a customer's probability of default is calculated following the methodology in Shumway (2001). In columns 5 and 6, a customer's likelihood of default is captured by the first principal component of Altman's (1968) Z-score, Ohlson's (1980) O-score, and Shumway's (2001) probability of bankruptcy. For each supplier and each default measure, we determine which of the supplier's identifiable customers has the highest probability of default and use this value to proxy for the supplier's risk of having a major customer default. *High Bankruptcy* is an indicator variable that is set to one if the particular default measure is above the sample median in a given year and zero otherwise. Both *Customer HHI* and *Total Major Customer Sales* are centered by subtracting their respective sample means before interacting them with *High Bankruptcy*. Control variables include *Beta Value-Weighted, Idiosyncratic Risk, Log(Market Value of Equity), Book-to-Market, Book Leverage, Momentum, Analyst Forecast Dispersion, Long-Term Growth Rate,* and *Return on Assets*. Control variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

		Customer Default Probability Measure					
		Bharath and Shumway (2008)		Shumway (2001)		First Principal Component	
	Pred. Sign	(1)	(2)	(3)	(4)	(5)	(6)
Customer HHI	+	-0.208		-0.312		-0.744	
		(-0.39)		(-0.57)		(-1.32)	
Customer HHI × High Bankruptcy	+	1.721**		1.710**		1.989***	
		(2.33)		(2.49)		(2.59)	
Total Major Customer Sales	+		-0.133		0.064		-0.251
			(-0.39)		(0.19)		(-0.68)
Total Major Customer Sales × High Bankruptcy	+		1.015**		0.751*		0.914**
			(2.49)		(1.86)		(2.03)
High Bankruptcy	+	0.047	0.033	-0.025	-0.045	-0.016	-0.029
		(0.57)	(0.39)	(-0.30)	(-0.55)	(-0.17)	(-0.31)
Control Variables		Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		5,138	5,138	5,685	5,685	5,023	5,023
Adjusted R^2		0.409	0.409	0.410	0.410	0.407	0.406
F-statistic (concentration measure + concentration measure × interaction term)		7.37***	8.85***	8.92***	9.13***	5.02**	4.60**

Table 6
Effect of Customer Switching Costs

This table reports results from OLS regressions relating the implied cost of equity to customer concentration measures and control variables for Compustat industrial firms from 1981 to 2011. The dependent variable in columns 1-8 is the implied cost of equity calculated by taking the mean of the four individual estimates and is in excess of the yield on 10-year Treasury bonds. The sample in columns 7 and 8 is restricted to supplier-years when a supplier discloses a customer with available Compustat data. *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. In columns 1-3 (4-6), supplier market share is the supplier's total sales divided the total sales of the supplier's 2-digit (3-digit) SIC industry. In columns 7 and 8, *Customer Cost of Goods Sold* is the ratio of a supplier's sales to a customer as a percentage of that customer's cost of goods sold *(cogs)*. *Low Switching Costs* is an indicator variable set to one if the particular measure is below the sample median in a given year and zero otherwise. Control variables include *Beta Value-Weighted, Idiosyncratic Risk, Log(Market Value of Equity), Book-to-Market, Book Leverage, Momentum, Analyst Forecast Dispersion, Long-Term Growth Rate,* and *Return on Assets.* Control variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

		Measure of Customer Switching Costs							
		Supplier market share based on 2-digit SIC industries			Supplier market share based on 3-digit SIC industries			Customer Cost of Goods Sold	
	Pred. Sign	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Major Customer	+	-0.063			-0.034				
		(-1.02)			(-0.54)				
Major Customer × Low Switching Costs	+	0.310***			0.290***				
		(4.02)			(3.76)				
Customer HHI	+		-0.215			-0.260		-0.217	
			(-0.47)			(-0.50)		(-0.47)	
Customer HHI × Low Switching Costs	+		1.054**			1.149**		1.075*	
			(2.05)			(2.00)		(1.72)	
Total Major Customer Sales	+			-0.152			-0.155		-0.095
				(-0.79)			(-0.77)		(-0.32)
Total Major Customer Sales × Low Switching Costs	+			0.661***			0.711***		0.700*
				(3.01)			(3.14)		(1.87)
Low Switching Costs	±	-0.741***	-0.687***	-0.714***	-0.595***	-0.543***	-0.574***	-0.177**	-0.175**
		(-13.41)	(-12.71)	(-12.99)	(-11.99)	(-11.45)	(-11.80)	(-2.04)	(-2.01)
Control Variables		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations		44,218	44,218	44,218	44,218	44,218	44,218	6,309	6,309
Adjusted R^2		0.457	0.457	0.457	0.456	0.456	0.456	0.394	0.395
F-statistic (concentration measure + concentration measure × interaction term)		24.68***	10.12***	16.77***	26.37***	11.78***	20.19***	3.61*	5.16**

Table 7
Effect of Trade Credit and Diversification

This table reports results from OLS regressions relating the implied cost of equity to customer concentration measures and control variables for Compustat industrial firms from 1981 to 2011. Variable definitions refer to Compustat designations where appropriate. The dependent variable in columns 1-6 is the implied cost of equity calculated by taking the mean of the four individual estimates and is in excess of the yield on 10-year Treasury bonds. *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. *Accounts Receivable* is total accounts receivable *(rect)* divided by book assets *(at)*. *Single-Segment Supplier* is an indicator variable set to one if a supplier operates in only one business segment and zero otherwise. The interaction term in columns 1-3 is *High Accounts Receivable,* which is an indicator variable set to one if the measure is above the sample median in a given year and zero otherwise. The interaction term in columns 4-6 is *Single-Segment Supplier.* Control variables include *Beta Value-Weighted, Idiosyncratic Risk, Log(Market Value of Equity), Book-to-Market, Book Leverage, Momentum, Analyst Forecast Dispersion, Long-Term Growth Rate,* and *Return on Assets.* Control variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

		Interaction Terms					
	Pred.	High Accounts Receivable			Single-Segment Supplier		
	Sign	(1)	(2)	(3)	(4)	(5)	(6)
Major Customer	+	-0.086			-0.036		
		(-1.50)			(-0.61)		
Major Customer × Interaction Term	+	0.424***			0.286***		
		(5.94)			(4.03)		
Customer HHI	+		0.065			-0.119	
			(0.22)			(-0.27)	
Customer HHI × Interaction Term	+		1.850***			1.010**	
			(3.95)			(2.05)	
Total Major Customer Sales	+			-0.132			-0.123
				(-0.90)			(-0.69)
Total Major Customer Sales × Interaction Term	+			1.204***			0.682***
				(6.15)			(3.33)
Interaction Term	±	0.250***	0.328***	0.271***	-0.264***	-0.209***	-0.246***
		(5.94)	(8.44)	(6.64)	(-6.30)	(-5.34)	(-6.03)
Control Variables		Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		44,218	44,218	44,218	44,218	44,218	44,218
Adjusted R^2		0.456	0.455	0.456	0.453	0.453	0.453
F-statistic (concentration measure + concentration measure × interaction term)		43.49***	24.78***	53.02***	25.01***	11.13***	19.27***

Table 8
Government Customer Concentration and the Implied Cost of Equity

This table reports results from OLS regressions relating the implied cost of equity to government customer concentration measures and control variables for Compustat industrial firms from 1981 to 2011. The dependent variable in columns 1-3 is the implied cost of equity calculated by taking the mean of the four individual estimates and is in excess of the yield on 10-year Treasury bonds. *Gov't. Major Customer* is an indicator variable set to one if a supplier discloses at least one federal government customer that accounts for at least 10% of its total sales. *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Gov't. Customer HHI* is the federal government customer sales-based Herfindahl-Hirschman Index. *Customer HHI* is the corporate customer sales-based Herfindahl-Hirschman Index. *Gov't. Total Major Customer Sales* is the fraction of a supplier's total sales to all federal government customers that account for at least 10% of total sales. *Total Major Customer Sales* is the fraction of a supplier's total sales to all corporate customers that account for at least 10% of total sales. All control variables are standardized to have a mean of zero and a standard deviation of one. Control variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

	Pred. Sign	Dependent Variable = Cost of Equity Mean (1)	(2)	(3)
Gov't. Major Customer	–	-0.191***		
		(-2.74)		
Major Customer	+	0.118***		
		(2.87)		
Gov't. Customer HHI	–		-0.380**	
			(-2.42)	
Customer HHI	+		0.562**	
			(2.38)	
Gov't. Total Major Customer Sales	–			-0.304***
				(-2.85)
Total Major Customer Sales	+			0.298***
				(2.69)
Beta Value-Weighted	+	0.102***	0.102***	0.102***
		(5.48)	(5.53)	(5.48)
Idiosyncratic Risk	+	0.496***	0.500***	0.496***
		(18.86)	(19.01)	(18.88)
Log(Market Value of Equity)	–	-0.480***	-0.484***	-0.481***
		(-16.79)	(-16.89)	(-16.76)
Book-to-Market	+	0.565***	0.564***	0.565***
		(22.66)	(22.63)	(22.69)
Book Leverage	+	0.573***	0.572***	0.573***
		(28.25)	(28.18)	(28.24)
Momentum	–	-0.191***	-0.190***	-0.190***
		(-12.96)	(-12.93)	(-12.95)
Analyst Forecast Dispersion	+	0.090***	0.090***	0.090***
		(5.06)	(5.06)	(5.04)
Long-Term Growth Rate	+	0.339***	0.338***	0.338***
		(15.12)	(15.07)	(15.06)
Return on Assets	±	-0.006	-0.005	-0.006
		(-0.34)	(-0.25)	(-0.31)
Industry × Year Fixed Effects		Yes	Yes	Yes
Observations		44,218	44,218	44,218
Adjusted R^2		0.452	0.452	0.452

Table 9
Customer Concentration and the Cost of Debt

This table reports results from OLS regressions relating the cost of debt to customer concentration measures and control variables for Compustat industrial firms. In Panel A, the sample consists of bank loans from Dealscan over the 1987 to 2011 period. In Panel B, the sample consists of public bond issues over the 1981 to 2011 period. Variable definitions refer to Compustat designations where appropriate. The dependent variable in columns 1-6 of Panel A is the natural logarithm of the amount the borrower pays over LIBOR for each dollar drawn down in basis points *(Log Loan Spread)*. The dependent variable in columns 1-6 of Panel B is the natural logarithm of the amount the borrower pays over the comparable maturity treasury security in basis points *(Log Public Debt Spread)*. *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. *Log(Book Assets)* is the natural logarithm of book assets *(at)*. *Market-to-Book* is market value of assets (book assets *(at)* plus market value of equity *(prcc_f*csho)* minus book value of equity *(ceq))* divided by book value of assets *(at)*. *Return on Assets* is income before extraordinary items *(ib)* divided by beginning of year book value of assets *(at)*. *Fixed Assets* is the ratio of the book value of property, plant, and equipment *(ppent)* to book value of assets *(at)*. *Book Leverage* is the book value of long-term debt *(dltt)* plus book value of debt in current liabilities *(dlc)* divided by book value of assets *(at)*. *Altman's Z-Score* is calculated as 1.2*(wcap/at)+1.4*(re/at)+3.3*(ebit/at)+(sale/at)+0.6*((prcc_f*csho+pstkrv)/lt). *Log(Loan Maturity)* is the natural logarithm of the number of months until the loan matures. *Log(Loan Size)* is the natural logarithm of the loan amount (in $ millions). All control variables are standardized to have a mean of zero and a standard deviation of one. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Customer Concentration and the Cost of Bank Debt

	Pred. Sign	Dependent Variable = Log Loan Spread (1)	(2)	(3)	(4)	(5)	(6)
Major Customer	+	0.058***			0.049**		
		(2.59)			(2.56)		
Customer HHI	+		0.458***			0.360***	
			(3.91)			(3.47)	
Total Major Customer Sales	+			0.250***			0.200***
				(4.66)			(4.38)
Log(Book Assets)	−	-0.487***	-0.487***	-0.484***	-0.312***	-0.311***	-0.309***
		(-41.18)	(-40.97)	(-40.71)	(-21.71)	(-21.68)	(-21.47)
Market-to-Book	−	-0.107***	-0.107***	-0.107***	-0.087***	-0.087***	-0.087***
		(-6.41)	(-6.39)	(-6.42)	(-6.27)	(-6.25)	(-6.27)
Return on Assets	−	-0.063***	-0.062***	-0.062***	-0.058***	-0.058***	-0.058***
		(-6.41)	(-6.41)	(-6.41)	(-7.07)	(-7.07)	(-7.07)
Fixed Assets	−	-0.103***	-0.105***	-0.105***	-0.077***	-0.079***	-0.079***
		(-7.51)	(-7.63)	(-7.69)	(-6.62)	(-6.72)	(-6.78)
Book Leverage	+	0.228***	0.229***	0.228***	0.169***	0.170***	0.170***
		(16.93)	(16.98)	(17.00)	(15.10)	(15.16)	(15.16)
Altman's Z-Score	−	-0.017	-0.016	-0.017	-0.028*	-0.027*	-0.028*
		(-0.92)	(-0.90)	(-0.95)	(-1.84)	(-1.82)	(-1.87)
Log(Loan Maturity)	+				0.002	0.001	0.001
					(0.15)	(0.09)	(0.14)
Log(Loan Amount)	+				-0.159***	-0.159***	-0.159***
					(-12.70)	(-12.71)	(-12.67)
Loan Type Fixed Effects		No	No	No	Yes	Yes	Yes
Industry × Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		14,789	14,789	14,789	14,789	14,789	14,789
Adjusted R^2		0.547	0.548	0.548	0.627	0.627	0.627

Table 9 – *(Continued)*

Panel B: Customer Concentration and the Cost of Public Debt

	Pred. Sign	Dependent Variable = Log Public Debt Spread					
		(1)	(2)	(3)	(4)	(5)	(6)
Major Customer	+	0.094***			0.068**		
		(2.91)			(2.41)		
Customer HHI	+		0.975***			0.812***	
			(5.10)			(4.75)	
Total Major Customer Sales	+			0.428***			0.342***
				(6.19)			(5.43)
Log(Book Assets)	–	-0.371***	-0.370***	-0.367***	-0.324***	-0.322***	-0.319***
		(-27.89)	(-28.12)	(-27.70)	(-25.00)	(-25.26)	(-24.98)
Market-to-Book	–	-0.126***	-0.126***	-0.125***	-0.089***	-0.090***	-0.089***
		(-5.64)	(-5.65)	(-5.68)	(-4.72)	(-4.75)	(-4.70)
Return on Assets	–	-0.090***	-0.092***	-0.092***	-0.090***	-0.092***	-0.092***
		(-7.20)	(-7.36)	(-7.39)	(-8.08)	(-8.22)	(-8.25)
Fixed Assets	–	-0.043**	-0.043**	-0.043**	-0.035**	-0.035**	-0.035**
		(-2.25)	(-2.25)	(-2.29)	(-2.14)	(-2.13)	(-2.16)
Book Leverage	+	0.090***	0.090***	0.088***	0.069***	0.068***	0.067***
		(6.03)	(5.98)	(5.91)	(5.22)	(5.16)	(5.10)
Altman's Z-Score	–	-0.054**	-0.050**	-0.054**	-0.049**	-0.046**	-0.049**
		(-2.15)	(-2.02)	(-2.16)	(-2.09)	(-1.97)	(-2.10)
Log(Loan Maturity)	+				0.142***	0.142***	0.141***
					(13.32)	(13.30)	(13.29)
Log(Loan Amount)	+				0.081***	0.079***	0.078***
					(4.84)	(4.70)	(4.65)
Security Type Fixed Effects		No	No	No	Yes	Yes	Yes
Industry × Year Fixed Effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations		7,016	7,016	7,016	7,016	7,016	7,016
Adjusted R^2		0.666	0.666	0.668	0.746	0.746	0.747

Table 10
Propensity Score Matched Sample Analysis

This table reports results relating the implied cost of equity to customer concentration measures and control variables for a propensity score matched sample using Compustat industrial firms from 1981 to 2011. The dependent variable in columns 1 and 2 of Panel A is *Major Customer,* which is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. Column 1 of Panel A shows the first-stage marginal effects from a conditional logistic regression used to calculate the propensity scores for the matching procedure. Column 2 of Panel A shows the marginal effects from the conditional logistic regression in column 1 using the subsample of matched suppliers. Panel B reports the distribution of propensity scores calculated from the regression in column 1 of Panel A for the subsample of matched suppliers. Panel C tabulates the univariate statistics comparing the mean characteristics of suppliers with and without major customers and their corresponding t-statistics. Panel D reports multivariate results relating the implied cost of equity to customer concentration measures. The dependent variable in columns 1-3 of Panel D is the implied cost of equity calculated by taking the mean of the four individual estimates and is in excess of the yield on 10-year Treasury bonds *(Cost of Equity Mean). Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. Control variables include *Beta Value-Weighted, Idiosyncratic Risk, Log(Market Value of Equity), Book-to-Market, Book Leverage, Momentum, Analyst Forecast Dispersion, Long-Term Growth Rate,* and *Return on Assets.* Control variables are defined in Table 1. All specifications include interacted year and industry fixed effects. Industries are defined at the 2-digit SIC level. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: Pre-Match Propensity Score Regression and Post-Match Diagnostic Regression

		Dependent Variable = Major Customer	
	Pred. Sign	Pre-Match Regression (1)	Post-Match Regression (2)
Beta Value-Weighted	+	0.013*	-0.007
		(1.88)	(-0.23)
Idiosyncratic Risk	+	0.075***	-0.000
		(7.40)	(-0.02)
Log(Market Value of Equity)	−	-0.090***	0.004
		(-7.52)	(0.33)
Book-to-Market	−	-0.027***	0.007
		(-3.38)	(0.84)
Book Leverage	−	-0.033***	0.003
		(-4.34)	(0.40)
Momentum	±	0.011***	0.001
		(2.90)	(0.20)
Analyst Forecast Dispersion	±	0.004	-0.003
		(1.05)	(-0.53)
Long-Term Growth Rate	±	0.009*	0.005
		(1.83)	(0.78)
Return on Assets	+	0.029***	0.002
		(5.86)	(0.40)
Industry × Year Fixed Effects		Yes	Yes
Observations		44,218	17,852
P-value of χ^2		<0.001	0.995
Pseudo R^2		0.054	<0.001

Table 10 – *(Continued)*

Panel B: Estimated Propensity Score Distributions

	Mean	Std. Dev.	Min	P25	P50	P75	Max
Propensity Score for Suppliers with a Major Customer (obs. = 8,926)	0.363	0.170	0.013	0.238	0.339	0.472	0.931
Propensity Score for Suppliers without a Major Customer (obs. = 8,926)	0.363	0.170	0.013	0.238	0.339	0.472	0.937
Difference	0.000	0.000	0.000	0.000	0.000	0.000	0.006

Panel C: Differences in Observables

	Suppliers with a Major Customer (obs. = 8,926)	Suppliers without a Major Customer (obs. = 8,926)		
	Mean	Mean	Difference	t-statistic
Dependent Variable				
Cost of Equity Mean	4.768	4.604	0.164	3.58***
Control Variables				
Beta Value-Weighted	1.159	1.156	0.003	0.34
Idiosyncratic Risk	0.446	0.446	0.000	0.14
Log(Market Value of Equity)	6.566	0.558	0.008	0.32
Book-to-Market	0.493	0.490	0.003	0.48
Book Leverage	0.188	0.187	0.001	0.19
Momentum	0.245	0.247	-0.002	-0.22
Analyst Forecast Dispersion	0.077	0.078	-0.001	-0.71
Long-Term Growth Rate	0.188	0.186	0.002	1.02
Return on Assets	0.077	0.077	0.000	0.38

Panel D: Multivariate Results

	Pred. Sign	Dependent Variable = Cost of Equity Mean		
		(1)	(2)	(3)
Major Customer	+	0.138*** (2.97)		
Customer HHI	+		0.567** (2.23)	
Total Major Customer Sales	+			0.355*** (2.91)
Control Variables		Yes	Yes	Yes
Industry × Year Fixed Effects		Yes	Yes	Yes
Observations		17,852	17,852	17,852
Adjusted R^2		0.409	0.409	0.409

Table 11
Instrumental Variables Regressions

This table reports results from 2-Stage Least Squares regressions relating the implied cost of equity to customer concentration measures and control variables using instrumental variables for Compustat industrial firms from 1981 to 2011. Panel A presents first-stage results, and Panel B presents second-stage results. We use the predicted values from the first-stage in the second-stage regressions. The dependent variables in columns 1-3 of Panel A are *Major Customer, Customer HHI,* and *Total Major Customer Sales,* respectively. *Major Customer* is an indicator variable set to one if a supplier discloses at least one corporate customer that accounts for at least 10% of its total sales. *Customer HHI* is the customer sales-based Herfindahl-Hirschman Index. *Total Major Customer Sales* is the fraction of a supplier's total sales to all customers that account for at least 10% of total sales. *Industry Major Customer* is the fraction of firms in the supplier's 3-digit SIC industry and year (excluding the supplier) that disclose sales to a major corporate customer. *Industry Customer HHI* is the average *Customer HHI* of firms in the supplier's 3-digit SIC industry and year (excluding the supplier). *Industry Total Major Customer Sales* is the average *Total Major Customer Sales* of firms in the supplier's 3-digit SIC industry and year (excluding the supplier). The dependent variable in columns 1-3 of Panel B is the implied cost of equity calculated by taking the mean of the four individual estimates and is in excess of the yield on 10-year Treasury bonds. All control variables are standardized to have a mean of zero and a standard deviation of one. All other variables are defined in Table 1. Continuous variables are winsorized at their 1st and 99th percentiles, and dollar values are expressed in 2009 dollars. Standard errors are corrected for heteroskedasticity and clustering at the supplier level (t-statistics are in parentheses). *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.

Panel A: First-Stage Results

		Industry Concentration Measures Used as Instrumental Variables		
	Pred. Sign	Industry Major Customer (1)	Industry Customer HHI (2)	Industry Total Major Customer Sales (3)
Industry Concentration Measure$_{t-2}$	+	0.524***	0.346***	0.500***
		(27.47)	(11.30)	(20.43)
Industry Concentration Measure$_{t-3}$	+	0.263***	0.129***	0.209***
		(14.03)	(5.86)	(9.28)
Beta Value-Weighted	+	0.013***	0.002***	0.004***
		(3.76)	(2.92)	(3.02)
Idiosyncratic Risk	+	0.027***	0.004***	0.012***
		(6.68)	(5.39)	(6.82)
Log(Market Value of Equity)	–	-0.045***	-0.007***	-0.019***
		(-8.41)	(-8.29)	(-8.78)
Book-to-Market	–	-0.008**	-0.001**	-0.003*
		(-2.01)	(-2.25)	(-1.95)
Book Leverage	–	-0.007*	-0.001	-0.003*
		(-1.84)	(-1.50)	(-1.89)
Momentum	±	0.008***	0.001*	0.003***
		(3.62)	(1.83)	(2.95)
Analyst Forecast Dispersion	±	0.006**	0.001*	0.002
		(2.12)	(1.80)	(1.53)
Long-Term Growth Rate	±	0.002	0.001*	0.003*
		(0.53)	(1.91)	(1.70)
Return on Assets	+	0.018***	0.003***	0.009***
		(5.19)	(4.63)	(5.60)
Observations		43,152	43,152	43,152
Adjusted R^2		0.176	0.084	0.169
Test of endogeneity, weak instruments, and overidentification				
Wu-Hausman F-statistic		167.16 ($p<0.001$)	14.02 ($p<0.001$)	90.55 ($p<0.001$)
F-statistic		3456.4 ($p<0.001$)	1310.2 ($p<0.001$)	3199.6 ($p<0.001$)
Partial R^2		0.138	0.057	0.129
Sargan Test ($Pr>\chi^2$)		0.226	0.334	0.330

Table 11 - *(Continued)*

Panel B: Second-Stage Results

	Pred. Sign	Dependent Variable = Cost of Equity Mean (1)	(2)	(3)
Predicted Major Customer	+	1.444*** (10.43)		
Predicted Customer HHI	+		4.785*** (3.90)	
Predicted Total Major Customer Sales	+			3.131*** (8.51)
Beta Value-Weighted	+	0.203*** (10.23)	0.225*** (11.68)	0.212*** (10.72)
Idiosyncratic Risk	+	0.455*** (17.88)	0.497*** (19.70)	0.461*** (18.27)
Log(Market Value of Equity)	−	-0.236*** (-7.49)	-0.267*** (-8.59)	-0.247*** (-7.91)
Book-to-Market	+	0.632*** (22.49)	0.616*** (22.00)	0.629*** (22.50)
Book Leverage	+	0.584*** (23.32)	0.557*** (22.59)	0.575*** (23.10)
Momentum	−	-0.152*** (-9.52)	-0.145*** (-9.21)	-0.149*** (-9.36)
Analyst Forecast Dispersion	+	-0.038* (-1.79)	-0.034 (-1.63)	-0.038* (-1.78)
Long-Term Growth Rate	+	0.241*** (8.85)	0.232*** (8.55)	0.231*** (8.47)
Return on Assets	±	-0.127*** (-5.87)	-0.130*** (-6.06)	-0.133*** (-6.18)
Observations		43,152	43,152	43,152
Adjusted R^2		0.166	0.180	0.175

Chisholm: Top sectors to watch in Q2

Financials, health care, and consumer staples could be poised to lead.

BY DENISE CHISHOLM, DIRECTOR OF QUANTITATIVE MARKET STRATEGY, QUANTITATIVE RESEARCH & INVESTMENTS, FIDELITY MANAGEMENT & RESEARCH COMPANY – 05/04/2022 - 7 MIN READ

Key takeaways

- Energy and utilities stocks were the main outperformers in the first quarter, as oil and gas prices rose and investors sought defensive plays.
- Looking ahead, a combination of low valuations and rising interest rates could give a boost to the financial sector.
- The consumer staples and health care sectors could also offer opportunity. Both look exceptionally cheap relative to their own histories.
- While many investors may be concerned about the impact of high inflation on markets, stocks have historically weathered inflationary periods well when the economy stays out of recession. Currently, the economy remains strong.

The first quarter this year saw some notable market shifts. Energy stocks experienced rapid price gains on rising oil and gas prices. And investors sought safety in defensive sectors amid rising market volatility, geopolitical tensions, and rising interest rates. But what sectors, factors, and themes could take leadership over the next few months? Fidelity's director of quantitative market strategy, Denise Chisholm, sees potentially favorable conditions ahead for the financial, health care, and consumer staples sectors.

Performance summary: The market gets defensive

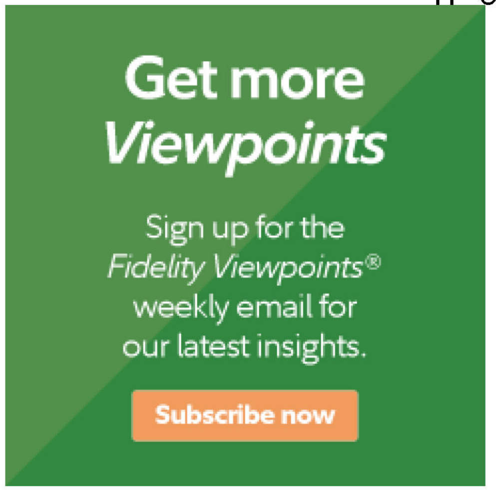
Energy stocks led the market in the first quarter, as Russia's invasion of Ukraine sent oil and gas prices soaring. Defensive stocks also outperformed, with utilities and consumer staples coming in second and third, respectively, as the market declined. Communication services, consumer discretionary, and information technology were the bottom performers.

Sector	Performance as of 3/31/22				Weight in S&P 500®
	Latest Quarter	1-Year	3-Year Annualized	Dividend Yield	
Communication Services*	-11.9%	-0.9%	15.5%	0.9%	9.4%
Consumer Discretionary	-9.0%	9.8%	18.6%	0.6%	12.0%
Consumer Staples	-1.0%	16.1%	14.0%	2.4%	6.1%
Energy	39.0%	64.3%	11.0%	2.8%	3.9%
Financials	-1.5%	14.7%	16.8%	1.7%	11.1%
Health Care	-2.6%	19.1%	16.5%	1.4%	13.6%
Industrials	-2.4%	6.1%	13.2%	1.4%	7.9%
Information Technology	-8.4%	20.9%	30.5%	0.8%	28.0%
Materials	-2.4%	13.9%	19.2%	1.7%	2.6%
Real Estate	-6.2%	25.8%	13.8%	2.3%	2.7%
Utilities	4.8%	19.9%	12.2%	2.9%	2.7%
S&P 500®	-4.6%	15.6%	18.9%	1.3%	

Past performance is no guarantee of future results. Sectors defined by the Global Industry Classification Standard (GICS®); see Index Definitions for details. Performance metrics reflect S&P 500 sector indexes.* Changes were made to the GICS framework on 9/24/18; historical S&P 500 communication services sector data prior to 9/24/18 reflect the legacy telecommunication services sector. The top three performing sectors over each period are shaded green; the bottom three are shaded red. It is not possible to invest directly in an index. All indexes are unmanaged. Percentages may not total 100% due to rounding. Source: Haver Analytics, FactSet, Fidelity Investments, as of 3/31/2022.

Scorecard: Favoring health care and financials

Low valuations in health care and financials have made those sectors appealing, while consumer discretionary's strong fundamentals may help the sector overcome high valuations. Energy and industrials also continue to look attractive. The utilities sector presents poor fundamentals and expensive valuations, earning it an underweight.

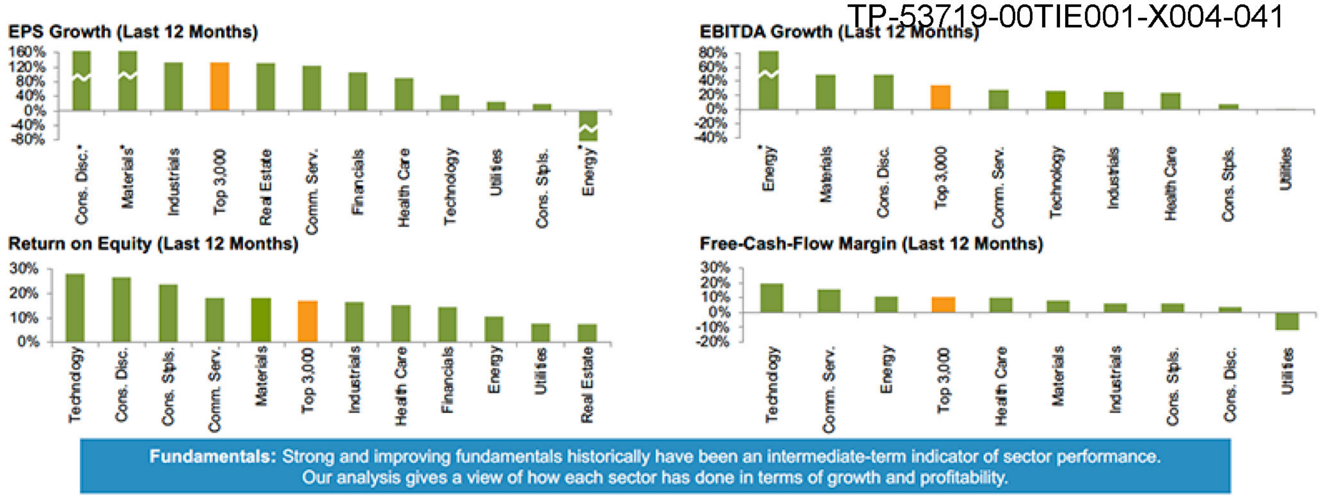


Sector	Strategist View (■ Overweight ■ Neutral ■ Underweight)	Longer — Time Horizon View — Shorter: Fundamentals	Valuations	Relative Strength	Comments
Communication Services*	Underweight			–	Defensive characteristics may hinder performance
Consumer Discretionary	Overweight	+	–	–	Median valuation more constructive; opportunities on equal-weighted basis
Consumer Staples	Overweight	–		+	Poor fundamentals may be priced in
Energy	Overweight			+	Good combination of fundamentals and valuation
Financials	Overweight		+		Recovering fundamentals bolster the outlook
Health Care	Overweight		+		Good combination of fundamentals and valuation
Industrials	Overweight		–		Other predictive valuation indicators still compelling
Information Technology	Underweight	+		–	Strong fundamentals increasingly priced in
Materials	Underweight	+	+		Fundamental indicators and valuation not predictive
Real Estate	Underweight	–			Elevated valuation likely to be a headwind
Utilities	Underweight	–	–	+	Defensive characteristics may hinder performance

Past performance is no guarantee of future results. Strategist view, fundamentals, valuations, and relative strength are based on the top 3,000 US stocks by market capitalization. Sectors defined by the GICS; see Index Definitions for details.* Historical communication services data has been restated back to 1962 to account for changes to the GICS framework made on 9/24/18. Strategist view is as of the date indicated based on the information available at that time, and may change based on market or other conditions. This is not necessarily the opinion of Fidelity Investments or its affiliates. Fidelity does not assume any duty to update any of the information. Overweight and underweight views represent opportunistic tilts in a hypothetical portfolio relative to broad market sector weights. Sector weights may vary depending on an individual's risk tolerance and goals. Time horizon view factors are based on historical analysis and are not a qualitative assessment by any individual investment professional. The top three sectors based on each time horizon view metric are shaded green; the bottom three are shaded red. See Glossary and Methodology for details. It is not possible to invest directly in an index. All indexes are unmanaged. Source: Haver Analytics, FactSet, Fidelity Investments, as of 3/31/2022.

Fundamentals: Materials, discretionary, and tech lead

Materials led the fundamental rankings, coming in second in earnings-per-share growth and EBITDA growth. Consumer discretionary and information technology also scored well. Utilities were the worst-performing sector by fundamental measures, coming in ninth in earnings-per-share growth, EBITDA growth, and free-cash-flow margin. Real estate and consumer staples also posted relatively poor fundamentals.

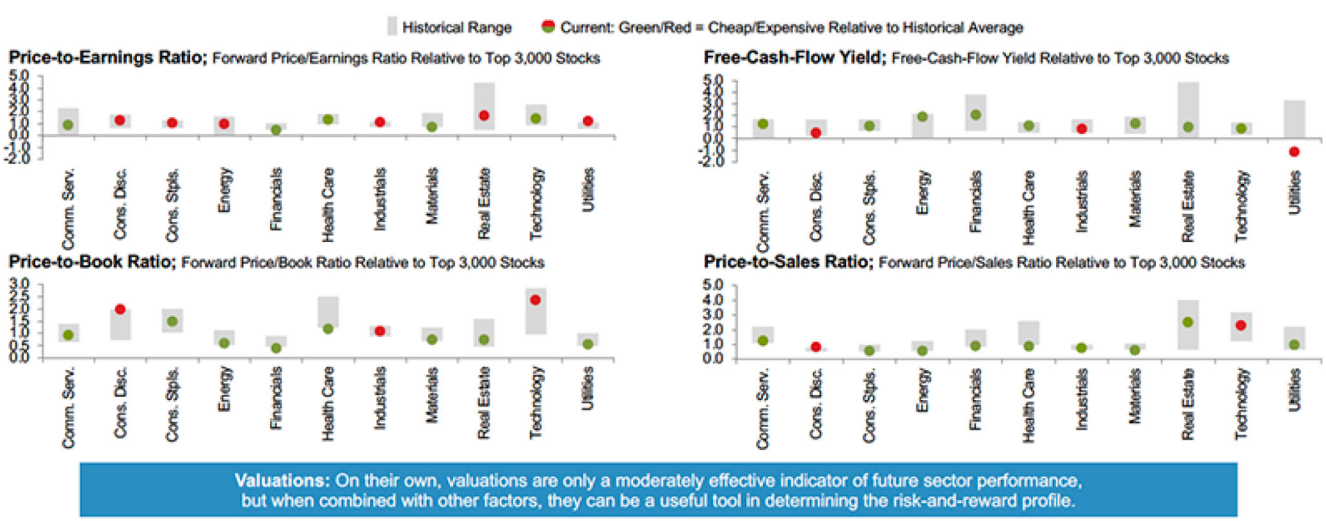


Fundamentals: Strong and improving fundamentals historically have been an intermediate-term indicator of sector performance. Our analysis gives a view of how each sector has done in terms of growth and profitability.

Past performance is no guarantee of future results. EPS = earnings per share. EBITDA = earnings before interest, taxes, depreciation, and amortization.* EPS growth values over the last 12 months for consumer discretionary, materials, and energy were 264%, 174%, and -158%, respectively. EBITDA Growth for energy over the same period was 375%. The financials and real estate sectors are not represented in the EBITDA growth or free-cash-flow margin charts because of differences in their business models and accounting standards. See Glossary and Methodology for further explanation Sectors based on the top 3,000 US stocks by market capitalization and defined by GICS. Communication services data restated back to 1962. Source: Haver Analytics, Fidelity Investments, as of 3/31/2022.

Valuations: Financials, health care, materials look cheap

Financials continued to have the cheapest valuations at the end of the first quarter, ranking as the least expensive sector by price-to-earnings and price-to-book ratios. The most expensive sectors were consumer discretionary, utilities, and industrials.



Valuations: On their own, valuations are only a moderately effective indicator of future sector performance, but when combined with other factors, they can be a useful tool in determining the risk-and-reward profile.

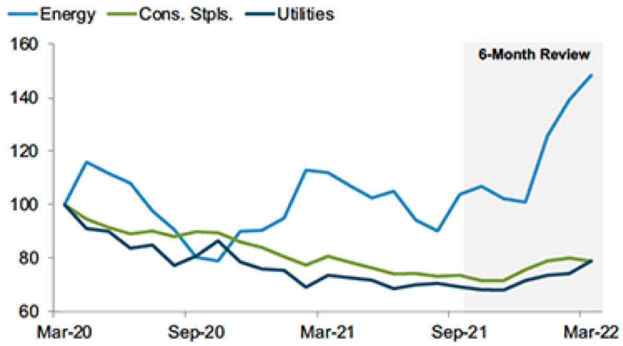
Past performance is no guarantee of future results. Free-cash-flow yield reflects free cash flow divided by market price per share; it is the inverse of the price-to-free-cash-flow ratio. Historical range excludes the top and bottom 5%. Green or red circles indicate if current levels are below or above the historical average, which excludes the top and bottom 5%. The financials and real estate sectors are not represented in the free-cash-flow yield or price-to-sales charts because of differences in their business models and accounting standards. See the Glossary and Methodology for further explanation. Historical range since January 1962. Sectors based on the top 3,000 US stocks by market capitalization and defined by GICS. Communication services data restated back to 1962. Source: Haver Analytics, Fidelity Investments, as of 3/31/2022.

Relative strength: Strength in energy, staples, and utilities

The energy, consumer staples, and utilities sectors exhibited the greatest relative strength over the past 6 months. Technology was weakest, followed by the consumer discretionary and communication services sectors.

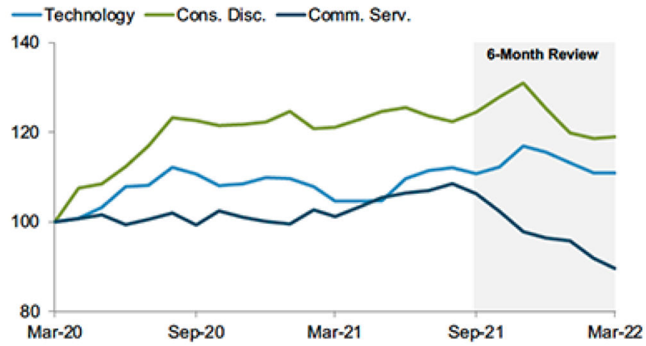
Sectors Exhibiting Relative Strength

Price Relative to the Russell 3000 Index



Sectors Exhibiting Relative Weakness

Price Relative to the Russell 3000 Index



Relative Strength: Stocks and sectors that have outperformed the broader market have tended to continue to do so.

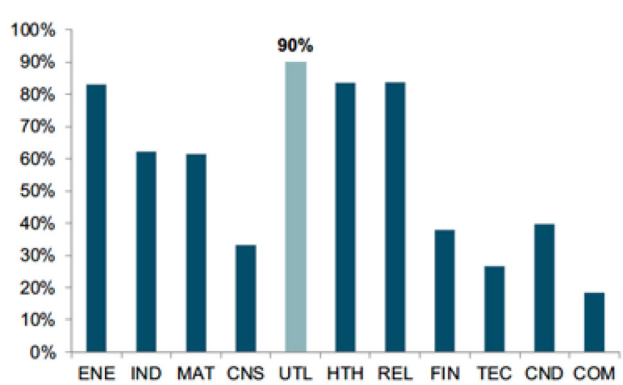
Past performance is no guarantee of future results. Relative strength compares the performance of each sector with the performance of the broad market, based on changes in the ratio of the securities' respective prices over time. See Glossary and Methodology for further explanation. Charts represent performance of sectors based on the top 3,000 stocks by market capitalization relative to the Russell 3000 Index. It is not possible to invest directly in an index. All indexes are unmanaged. Source: FactSet, Fidelity Investments, as of 3/31/2022.

Utilities on top in February, but perhaps not for long

Energy stocks have garnered a lot of attention, but in February utilities was the only sector with monthly returns in the 90th percentile of its historical range. In the past, powerful utilities rallies have signaled investors getting too defensive. The market typically has gained, and utilities have underperformed, in 12-month periods after top-decile monthly relative returns for the sector.

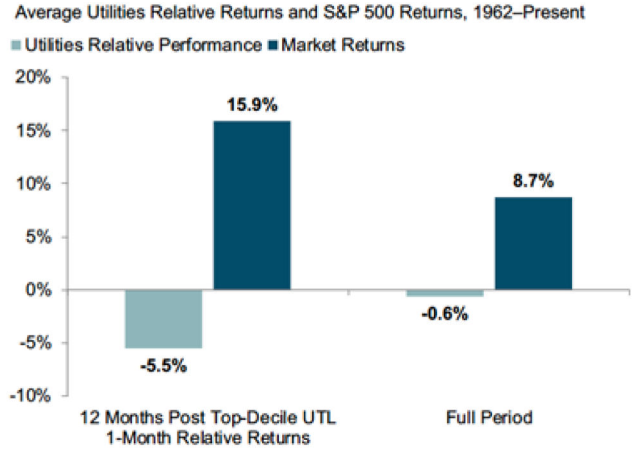
Utilities Had One of Their Strongest-Ever Months

Percentile Rank of February 2022 Sector Relative Returns vs. History of 1-Month Relative Returns, 1962–Present



With Utilities, Past Isn't Usually Prologue

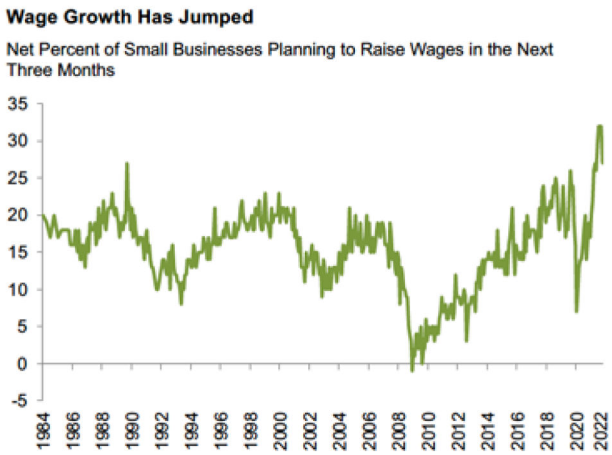
Average Utilities Relative Returns and S&P 500 Returns, 1962–Present

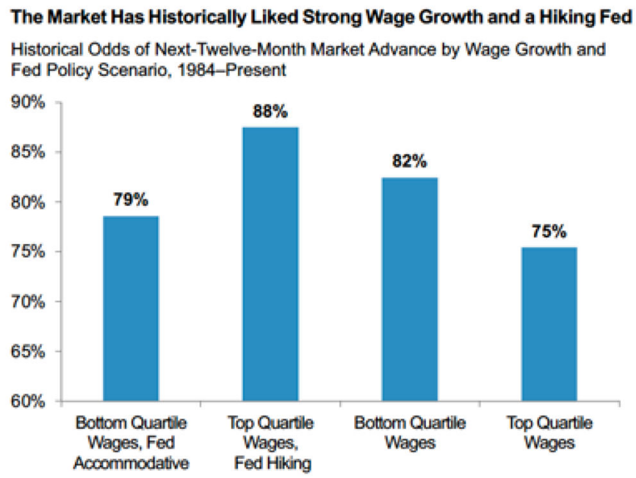


Past performance is no guarantee of future results. UTL: Utilities. Sector analysis based on the S&P 500. Returns are relative to the S&P 500. Source: Haver Analytics, FactSet, Fidelity Investments, as of 3/16/2022.

Rising rates may not be a problem

The Federal Reserve has begun hiking interest rates, trying to tamp down inflation that stems in part from rapid wage growth. That kind of scenario has worked out well for investors in the past. Historically, the market has been more likely to advance amid a tightening Fed and strong wage growth than when the Fed is accommodative and wage growth is weak.

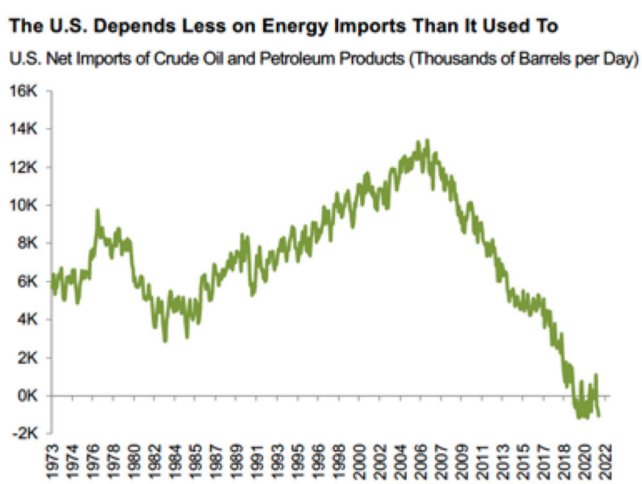


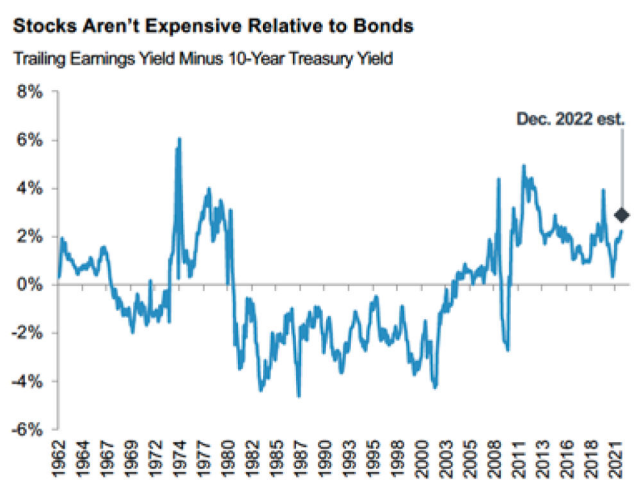


Past performance is no guarantee of future results. Analysis based on the S&P 500. Source: Haver Analytics, FactSet, Fidelity Investments, as of 2/28/2022.

This isn't the 1970s

Inflation is high and we are facing an energy supply shock. Are we heading into a replay of the energy crisis and bear market of the 1970s? It's unlikely. The US economy is far less dependent on energy imports than it was then, and stocks are much less expensive relative to bonds than they were 5 decades ago, so both look less vulnerable.

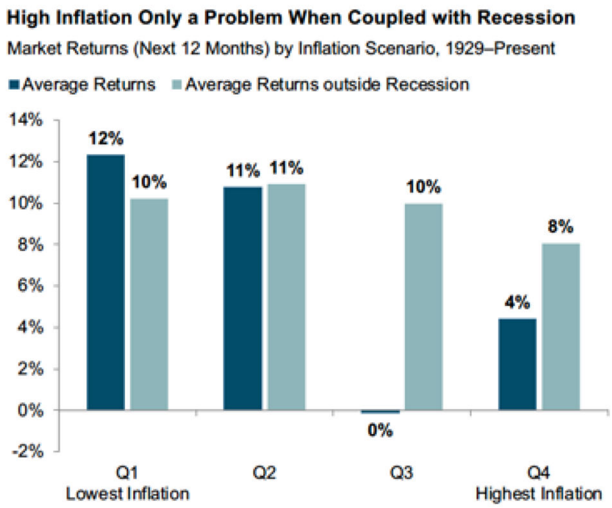


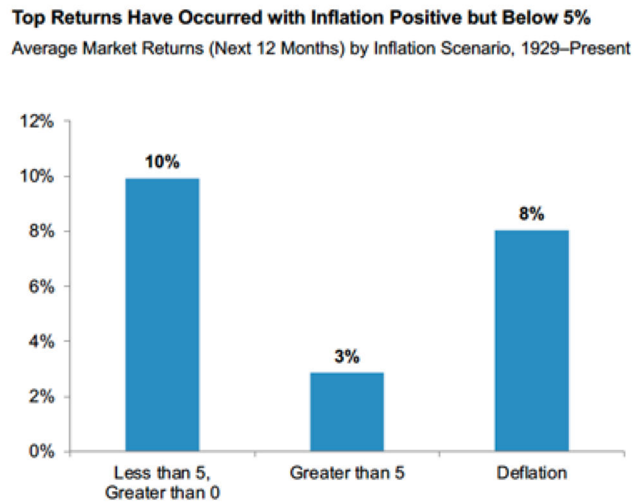


Past performance is no guarantee of future results. Dec. 2022 estimate calculated based on current earnings estimates and a 3% 10-year Treasury yield. Analysis based on the top 3,000 US stocks by market capitalization. Source: Haver Analytics, FactSet, Fidelity Investments, as of 2/28/2022.

A strong economy trumps high inflation

In the past, the stock market has weathered high inflation well when the economy stays out of recession. Today, the economy is strong and healthy employment may bode well for future growth. I expect inflation to decline but stay above average levels. How far it falls will matter: Historically, annual inflation below 5% has corresponded with strong stock performance.

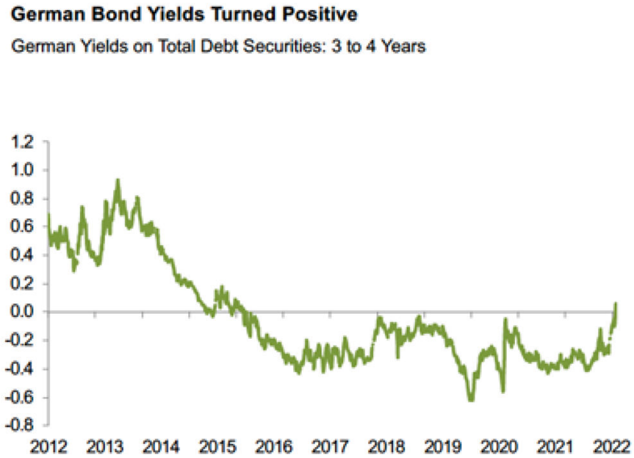


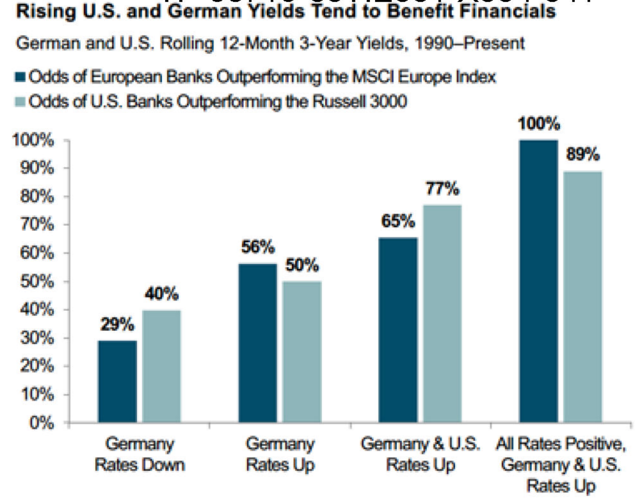


Past performance is no guarantee of future results. Analysis based on the top 3,000 US stocks by market capitalization. Source: Haver Analytics, FactSet, Fidelity Investments, as of 12/31/2021.

Global interest rates look bullish for financials

Financials have struggled with low interest rates in the US and negative rates around the world. Now yields are rising in the US and in Germany, and German bond yields have turned positive after languishing below zero for years. In the past, simultaneously positive and climbing yields in the US and Germany have been great news for financials, both domestically and in Europe.

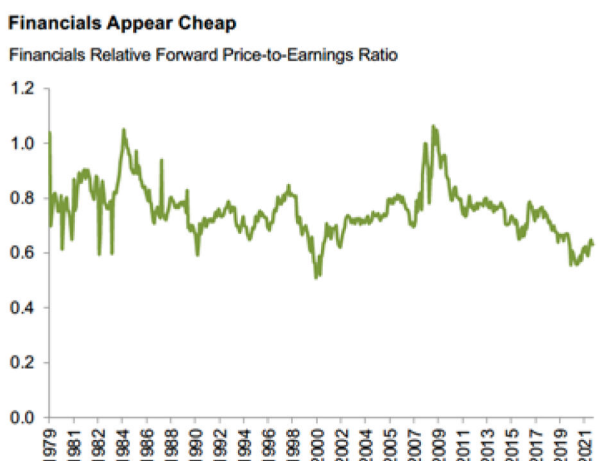


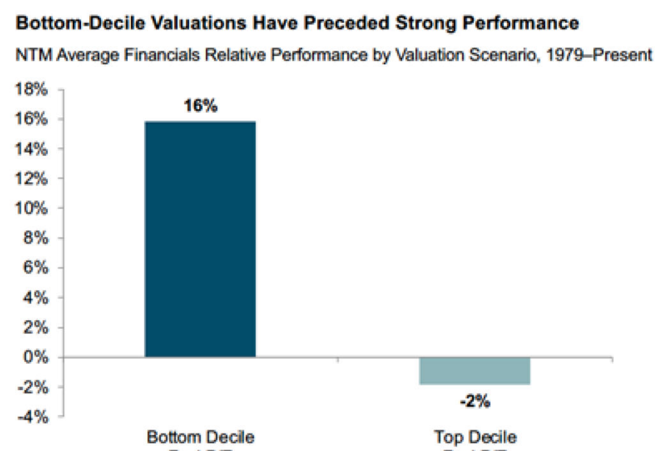


Past performance is no guarantee of future results. Analysis based on the MSCI Europe Index and the top 3,000 US stocks by market capitalization. Source: Haver Analytics, FactSet, Fidelity Investments, as of 2/28/2022.

Financials' valuations may position the sector to outperform

Financials also are very cheap relative to their own history. Bottom-decile valuations are uncommon, but when they've occurred, the sector historically has advanced 90% of the time over the following 12 months, outperforming the market by an average of 16%.

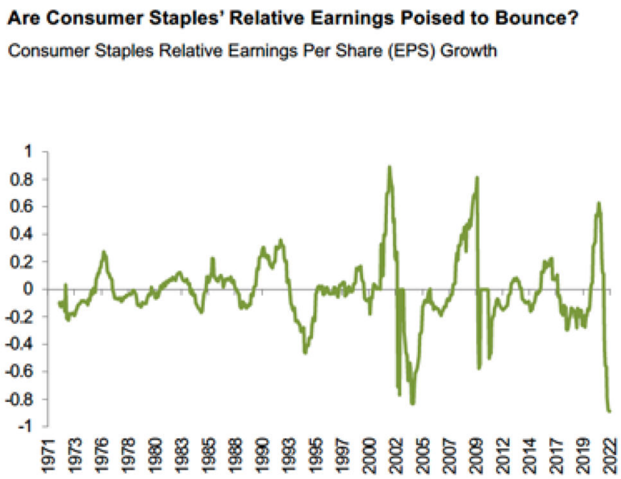


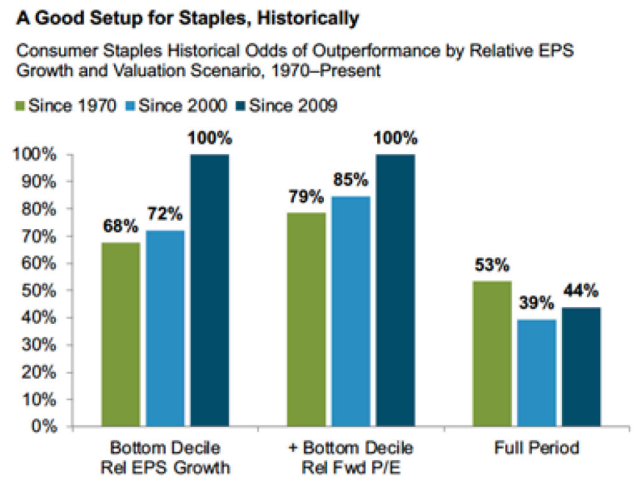


Past performance is no guarantee of future results. NTM: Next twelve months. Valuation measured by Fwd P/E (forward price-to-earnings) ratio. A forward P/E ratio typically uses an average of analysts' published earnings estimates for the next 12 months. Sector analysis based on the top 3,000 stocks by market capitalization. Returns and valuation metrics relative to the Russell 3000 Index. Source: Haver Analytics, FactSet, Fidelity Investments, as of 2/28/2022.

Consumer staples appear to be on sale

The consumer staples sector has been trading at an extreme discount to its own history, likely because its earnings growth has lagged far behind the market's in recent years. The combination of weak past earnings growth and rock-bottom valuations historically has been a buying opportunity.

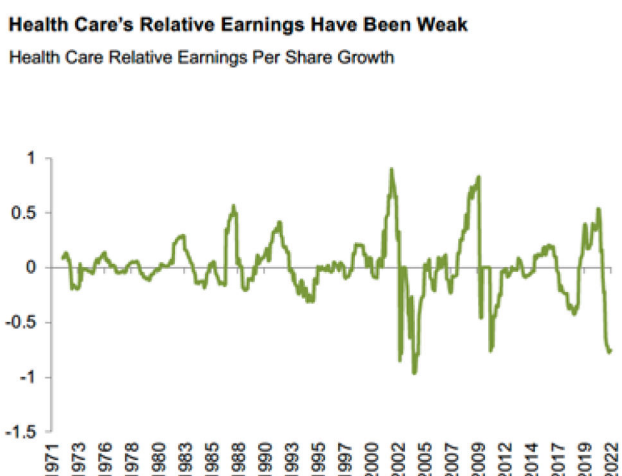


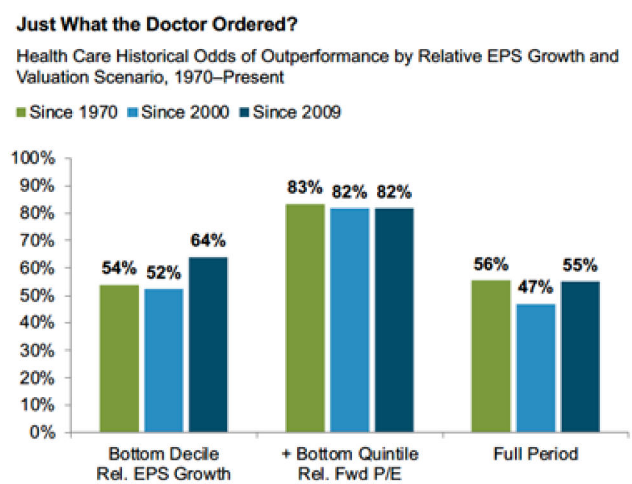


Past performance is no guarantee of future results. Fwd P/E: Forward price-to-earnings. A forward P/E ratio typically uses an average of analysts' published earnings estimates for the next 12 months. Sector analysis based on the top 3,000 stocks by market capitalization. Returns and valuation metrics relative to the Russell 3000 Index. Source: Haver Analytics, FactSet, Fidelity Investments, as of 2/28/2022.

Health care's setup looks similar

Like staples, health care has produced weak earnings growth relative to the market and sports a low valuation compared to its own history. Also like staples, the combination has tended to precede outperformance—and health care has the additional advantage of high and rising margins.

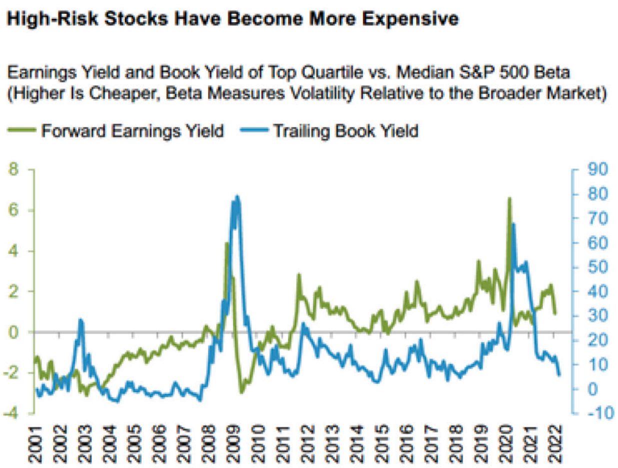


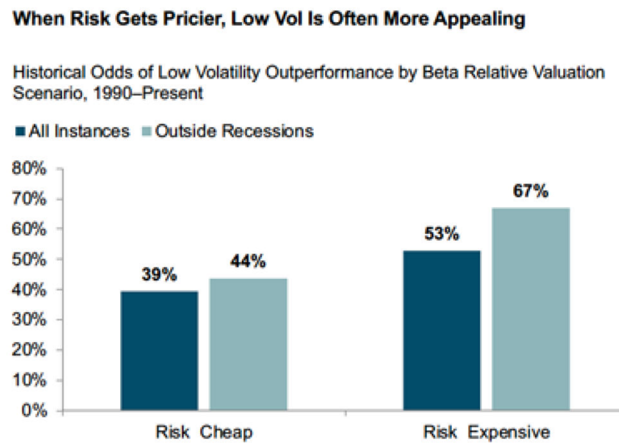


Past performance is no guarantee of future results. EPS: Earnings per share. Fwd P/E: Forward price-to-earnings. A forward P/E ratio typically uses an average of analysts' published earnings estimates for the next 12 months. Sector analysis based on the top 3,000 stocks by market capitalization. Returns and valuation metrics relative to the Russell 3000 Index. Source: Haver Analytics, FactSet, Fidelity Investments, as of 2/28/2022.

Low-volatility factor looks more appealing

The low-volatility factor has struggled over the last several years, as riskier fare has been relatively inexpensive. Now the relative valuations of high-risk stocks have risen, while low-vol factor valuations hover around their 50th percentile. Historically, the low-vol factor's odds of outperformance have improved when risk gets expensive, especially outside of recession.





Past performance is no guarantee of future results. Relative valuation of beta determined by calculating the average percentile ranks of relative forward earnings yield and relative book yield of the top quartile of stocks in the S&P 500 based on beta (equal weighted). Relative valuations in the top half of instances are considered cheap, while those in the bottom half are considered expensive. A stock's beta is a measure of its volatility relative to that of the broader market. Earnings yield: Earnings per share divided by share price, the inverse of the price-to-earnings (P/E) ratio. Book yield: Book value (reported accumulated profits and capital) divided by share price. It is the inverse of the price-to-book (P/B) ratio. Low volatility returns and valuations are relative to the S&P 500 index. Source: Haver Analytics, FactSet, Fidelity Investments, as of 2/28/2022.

Next steps to consider


-

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Get industry-leading investment analysis.


-

Research Fidelity sector funds

Get the details on the lineup of mutual funds.

Follow Denise Chisholm on LinkedIn

She uses history to share probability analysis on the US equity sectors.

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Glossary

Cycle Hit Rate: Calculates the frequency of a sector outperforming the broader equity market over each business cycle phase since 1962.

Dividend Yield: Annual dividends per share divided by share price. Earnings before Interest, Taxes, Depreciation, and Amortization (EBITDA): A non-GAAP measure often used to compare profitability between companies and industries, because it eliminates the effects of financing and accounting decisions.

Earnings before Interest, Taxes, Depreciation, and Amortization (EBITDA): A non-GAAP measure often used to compare profitability between companies and industries, because it eliminates the effects of financing and accounting decisions.

Earnings-per-Share Growth: Measures the growth in reported earnings per share over the specified past time period.

Earnings Yield: Earnings per share divided by share price. It is the inverse of the price-to-earnings (P/E) ratio.

Enterprise Value: A measure of a company's total value that includes its market capitalization as well as short- and long-term debt and cash on its balance sheet.

Free Cash Flow (FCF): The amount of cash a company has remaining after expenses, debt service, capital expenditures, and dividends. High free cash flow typically suggests stronger company value.

Free-Cash-Flow Margin: The amount of free cash flow as a percentage of revenue. High FCF margin often denotes strong profitability.

Free-Cash-Flow Yield: Free cash flow per share divided by share price. A high FCF yield often represents a good investment opportunity, because investors would be paying a reasonable price for healthy cash earnings.

Full-Phase Average Performance: Calculates the (geometric) average performance of a sector in a particular phase of the business cycle and subtracts the performance of the broader equity market.

Median Monthly Difference: Calculates the difference in the monthly performance of a sector compared with the broader market, and then takes the midpoint of those observations.

Price-to-Book (P/B) Ratio: The ratio of a company's share price to reported accumulated profits and capital.

Price-to-Earnings (P/E) Ratio: The ratio of a company's current share price to its reported earnings. A forward P/E ratio typically uses an average of analysts' published earnings estimates for the next 12 months.

Price-to-Sales (P/S) Ratio: The ratio of a company's current share price to reported sales.

Relative Strength: The comparison of a security's performance relative to a benchmark, typically a market index.

Return on Equity (ROE): The amount, expressed as a percentage, earned on a company's common stock investment for a given period.

Risk Decomposition: A mathematical analysis that estimates the relative contribution of various sources of volatility.

Methodology

Strategist View: Our sector strategist, Denise Chisholm, tracks key indicators that have influenced the historical likelihood of outperformance of each sector. This historical probability analysis informs the Strategist Views.

Fundamentals: Sector rankings are based on equally weighting the following four fundamental factors: EBITDA growth, earnings growth, ROE, and FCF margin. However, we evaluate the financials and real estate sectors only on earnings growth and ROE because of differences in their business models and accounting standards.

Relative Strength: Compares the strength of a sector versus the S&P 500 index over a six-month period, with a one-month reversal on the latest month; identifying relative strength patterns can be a useful indicator for short-term sector performance.

Relative Valuations: Valuation metrics for each sector are relative to the S&P 500. Ratios compute the current relative valuation divided by the 10-year historical average relative valuation, eliminating the top 5% and bottom 5% values to reduce the effect of potential outliers. Sectors are then ranked by their weighted average ratios, weighted as follows: P/E: 37%; P/B: 21%; P/S: 21%; and FCF yield: 21%. However, the financials and real estate sectors are weighted as follows: P/E: 65% and P/B: 35%.

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References to specific investment themes are for illustrative purposes only and should not be construed as recommendations or investment advice. Investment decisions should be based on an individual's own goals, time horizon, and tolerance for risk.

This piece may contain assumptions that are "forward-looking statements," which are based on certain assumptions of future events. Actual events are difficult to predict and may differ from those assumed. There can be no assurance that forward-looking statements will materialize or that actual returns or results will not be materially different from those described here.

Past performance is no guarantee of future results.

Investing involves risk, including risk of loss.

All indexes are unmanaged, and performance of the indexes includes reinvestment of dividends and interest income, unless otherwise noted. Indexes are not illustrative of any particular investment, and it is not possible to invest directly in an index.

Stock markets are volatile and can fluctuate significantly in response to company, industry, political, regulatory, market, or economic developments. Investing in stock involves risks, including the loss of principal.

Because of their narrow focus, sector funds tend to be more volatile than funds that diversify across many sectors and companies.

Index Definitions: The Consumer Price Index (CPI) is a monthly inflationary indicator that measures the change in the cost of a fixed basket of products and services; the unadjusted number is often called "headline CPI." "Core CPI" excludes food and energy prices.

The Russell 3000 ® Index is a market capitalization-weighted index designed to measure the performance of the 3,000 largest companies in the U.S. equity market.

The S&P 500 ® index is a market capitalization-weighted index of 500 common stocks chosen for market size, liquidity, and industry group representation to represent U.S. equity performance. S&P 500 is a registered service mark of Standard & Poor's Financial Services LLC. Sectors and industries are defined by the Global Industry Classification Standard (GICS).

The S&P 500 sector indexes include the standard GICS sectors that make up the S&P 500 index. The market capitalization of all S&P 500 sector indexes together comprises the market capitalization of the parent S&P 500 index; each member of the S&P 500 index is assigned to one (and only one) sector.

Sectors are defined as follows: **Consumer discretionary:** companies that provide goods and services that people want but don't necessarily need, such as televisions, cars, and sporting goods; these businesses tend to be the most sensitive to economic cycles. **Consumer staples:** companies that provide goods and services that people use on a daily basis, like food, household products, and personal-care products; these businesses tend to be less sensitive to economic cycles. **Energy:** companies whose businesses are dominated by either of the following activities: the construction or provision of oil rigs, drilling equipment, or other energy-related services and equipment, including seismic data collection; or the exploration, production, marketing, refining, and/or transportation of oil and gas products, coal, and consumable fuels. **Financials:** companies involved in activities such as banking, consumer finance, investment banking and brokerage, asset management, and insurance and investments. **Health care:** companies in 2 main industry groups: health care equipment suppliers and manufacturers, and providers of health care services; and companies involved in the research, development, production, and marketing of pharmaceuticals and biotechnology products. **Industrials:** companies whose businesses manufacture and distribute capital goods, provide commercial services and supplies, or provide transportation services. **Materials:** companies that are engaged in a wide range of commodity-related manufacturing. **Real estate:** companies in 2 main industry groups—real estate investment trusts (REITs), and real estate management and development companies. **Technology:** companies in technology software and services and technology hardware and equipment. **Telecommunication services:** companies that provide communications services primarily through fixed-line, cellular, wireless, high-bandwidth, and/or fiber-optic cable networks. **Utilities:** companies considered to be electric, gas, or water utilities, or companies that operate as independent producers and/or distributors of power.

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Markets

Goldman Lifts Yield Forecasts, Sees 10-Year Treasuries at 3.3%

- Also raises outlook for German and British equivalents
- Yields have dropped this week, anticipating slower growth

By Amelia Pollard
May 12, 2022, 9:25 AM EDT *Updated on May 12, 2022, 10:46 AM EDT*

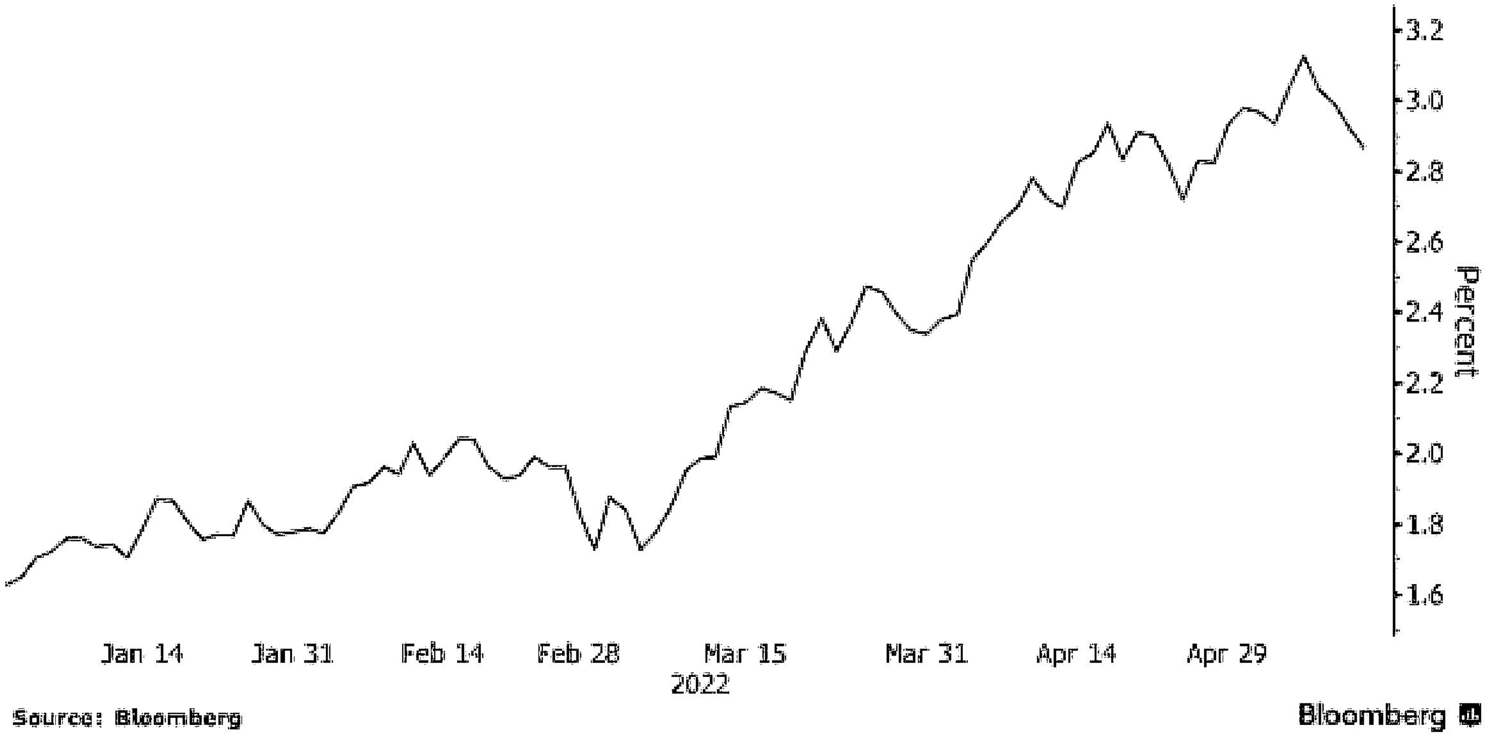
Goldman Sachs Group Inc. has lifted its expectations for where it sees major developed-market bond yields at the end of 2022 following the recent increase in global rates, even as yields dropped this week.

For the US, Germany and UK, Goldman anticipates yields will be higher at year-end, citing the combination of "front-loading of hikes, higher terminal rate pricing, and rebuilding bond risk premia."

Goldman sees the 10-year Treasury yield, currently around 2.85%, finishing the year near 3.3%. It previously expected a rate of around 2.7%, interest-rate strategists led by Praveen Korapaty wrote in a note Thursday. Their forecast for the German 10-year yield increased to 1.25% from 0.75%; for the U.K. 10-year, to 2.25% from 1.95%.

Yield Surge

US 10-year Treasury rate has nearly doubled this year



Although Goldman's economists believe inflation has largely peaked in G-10 markets and that there will be "significant growth deceleration" in countries like the US and UK, central banks will probably keep raising rates as inflation remains above their target levels, the strategists wrote.

"With markets in many cases already pricing close to our baseline for policy rates, we expect yields can move higher, but not necessarily significantly beyond what the forwards imply," they wrote.

(Adds chart and detail throughout.)

ENTERGY TEXAS, INC.
PUBLIC UTILITY COMMISSION OF TEXAS
DOCKET NO. 53719

Response of: Entergy Texas, Inc. to the First Set of Data Requests of Requesting Party: Texas Industrial Energy Consumers	Prepared By: Ann Bulkley Sponsoring Witness: Ann Bulkley Beginning Sequence No. LC43 Ending Sequence No. LC43

Question No.: TIEC 1-5 Part No.: Addendum:

Question:

In regard to Ms. Bulkey's ECAPM analysis please provide any academic publication subject to a peer review that supports using Value Line adjusted betas in the construction of the ECAPM.

Response:

Please see the attachments (TP-53719-00TIE001-X005-001, TP-53719-00TIE001-X005-002, and TP-53719-00TIE001-X005-003).

TP-53719-00TIE001-X005-001
Energy Studies Review Vol. 18, No. 2, 2011

COST OF EQUITY FOR ENERGY UTILITIES: BEYOND THE CAPM

STÉPHANE CHRÉTIEN & FRANK COGGINS

ABSTRACT

The Capital Asset Pricing Model (CAPM) is applied in regulatory cases to estimate the required rate of return, or cost of equity, for low-beta, value-style energy utilities, despite the model's well documented mispricing of investments with similar characteristics. This paper examines CAPM-based estimates for a sample of American and Canadian energy utilities to assess the risk premium error. We find that the CAPM significantly underestimates the risk premium for energy utilities compared to its historical value by an annualized average of more than 4%. Two CAPM extensions, the Fama-French model and an adjusted CAPM, provide econometric estimates of the risk premium that do not present a significant misevaluation.

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1. INTRODUCTION

An important aspect of the regulatory process for energy utilities is the determination of their equity rate of return. This return, also known as the cost of equity capital, represents the expected remuneration of the shareholders of the utilities. It is a crucial component of their total cost of capital, which is central to their investment policy and serves as a basis for setting up the rates to their customers. The purpose of this paper is to highlight the problems of the most commonly used model to determine the equity rate of return for energy utilities and to propose two alternative models that empirically improve on the estimation. By providing new direct and focused evidence for energy utilities, our analysis contributes to the knowledge of energy, regulatory and financial economists, as well as regulators, who are concerned with rate determination.

Regulatory bodies, like the National Energy Board in Canada or the Federal Energy Regulatory Commission in the United States, have the mandate to set the equity rate of return so that it is fair and reasonable. Specifically, according to Bonbright, Danielsen and Kamerschen (1988, Chap. 10), the return should provide the ability to attract and retain capital (the capital-attraction criterion), encourage efficient managerial practice (the management-efficiency criterion), promote consumer rationing (the consumer-rationing criterion), give a reasonably stable and predictable rate level to ratepayers (the rate-level stability and predictability criterion) and ensure fairness to investors (the fairness to investors criterion). While the first four criteria are designed primarily in the interest of the consuming public, the last criterion acts as an equally-important protection for private owners against confiscatory regulation. Its requirement involves determining the return available from the application of the capital to other enterprises of like risk, which demands an understanding of the risk-return relationship in the equity market.

Traditionally, the regulated return has been set through hearings, where arguments on the issue of fairness could be debated. But since the 1990s, numerous boards have adopted an annual mechanism known as a "rate of return formula" or a "rate adjustment formula". This mechanism determines automatically the allowed rate of return through a calculation that explicitly accounts for the risk-return relationship in the equity market. The use of rate adjustment formulas is particularly prevalent in Canada since the landmark March 1995 decision by the National Energy Board (Decision RH-2-94), which sets the stage for the widespread adoption of closely related formulas by provincial regulators.

Most rate adjustment formulas use a method known as the Equity Risk Premium method.[1] This method can be summarized as calculating a utility's equity rate of return as the risk-free rate of return plus a premium that reflects its risk. The risk-free rate is usually related to the yield on a long-term government bond. The risk premium is obtained from the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965), a classic model of capital market equilibrium. It is equal to the utility's beta, a measure of its systematic risk, multiplied by the market portfolio risk premium. The Equity Risk Premium method has a number of

[1] There exist other methods for estimating the rate of return, most notably the Comparable Earnings method and the Discounted Cash Flows method. See Morin (2006) for a description. These methods are generally not directly incorporated in the rate adjustment formulas.

advantages. First, it is supported by a solid theoretical foundation in the academic literature, thus providing a sound basis for understanding the risk-return relationship. Second, it can be estimated based on stock returns, thereby making it more objective than other methods, and relating it to current market conditions. Third, it is relatively simple to apply and requires data that can be obtained easily.

The Equity Risk Premium method is not, however, without shortcomings. Arguably its most criticized feature is the use of the CAPM as the basis to determine the risk premium. While the CAPM is one of the most important developments in finance, research over the last forty years has produced a large body of work critical of the model. On the theoretical side, Cochrane (1999) summarizes the current most prevalent academic view: "In retrospect, it is surprising that the CAPM worked so well for so long. The assumptions on which it is built are very stylized and simplified."[2] For example, at least since Merton (1973), it is recognized that factors, state variables or sources of priced risk beyond the movements in the market portfolio (the only risk factor in the CAPM) might be needed to explain why some risk premiums are higher than others. On the empirical side, the finance literature abounds with CAPM deficiencies (so-called "anomalies"). Fama and French (2004) review this literature to highlight that the CAPM is problematic in the estimation of the risk premium of low-beta firms, small-capitalisation firms and value (or low-growth) firms. While these problems have been well documented in the finance literature, their effects have not yet been fully explored for energy utilities, which may be part of the reasons why the CAPM is still widely used in rate adjustment formulas. In particular, as the CAPM does not empirically provide a valid risk-return relationship for the equity market, it might fall short of the requirement associated with the fairness to investors' criterion.

Considering the importance of the CAPM in determining the regulated equity rate of return, the objectives of this paper are two-folds. First, we re-examine the use of the model in the context of energy utilities to determine if it is problematic. As utilities are typically low-beta, value-oriented investments, the finance literature suggests that the model will have difficulties in estimating their risk premiums. We analyze the issue empirically by estimating the model and its resulting risk premiums for a sample of Canadian and American energy utilities mostly related to the gas distribution sector, and by testing for the presence of significant differences between the model's risk premium estimates and the historical ones.

Second, we implement two alternative models that are designed to circumvent some of the empirical problems of the CAPM. The first alternative is a three-factor model proposed by Fama and French (1993) (the Fama-French model hereafter). This model has been used to estimate the cost of equity by Fama and French (1997) for general industrial sectors and by Schink and Bower (1994) for the utilities sector in particular. The second alternative is a modified CAPM that includes the adjustments proposed by Blume (1975) and Litzenberger, Ramaswamy and Sosin (1980) (the Adjusted CAPM hereafter). The Fama-French model and the Adjusted CAPM provide useful comparisons with the CAPM on the estimation of the risk premiums of energy utilities.

Our empirical results can be summarized as follows. First, the CAPM significantly underestimates the risk premiums of energy utilities compared to their

[2] Cochrane (1999), p. 39.

historical values. The underestimations are economically important, with annualized averages of respectively 4.5% and 6.2% for the Canadian and American gas utilities we consider, and are consistent with the finance literature on the mispricing of low-beta, value-oriented stocks. Second, the Fama-French model and the Adjusted CAPM are both able to provide costs of equity that are not significantly different from the historical ones. Our results show that the value premium, in the case of the Fama-French model, and a bias correction, in the case of the Adjusted CAPM, are important in eliminating the CAPM underestimations. Both models suggest average risk premiums between 4% and 8% for gas utilities portfolios, and are relevant at the individual utility level as well as at the utilities sector level.

Overall, we conclude that the CAPM is problematic in estimating econometrically the cost of equity of energy utilities. The Fama-French model and the Adjusted CAPM are well specified for this purpose as they reduce considerably the estimation errors. These models could thus be considered as alternatives to the CAPM in the Equity Risk Premium method employed by regulatory bodies to obtain the risk-return relationship for the fairness to investors' criterion.

The CAPM dates back to the mid-1960s. While the model is tremendously important, there has been a lot of progress over the last 45 years in the understanding of the cross-section of equity returns. It should be clear that the goals of this paper are not to implement full tests of asset pricing models or examine comprehensively the numerous models in the equity literature. Focusing on energy utilities, this paper is an application of the CAPM and two reasonable and relevant alternatives to the problem of cost of equity estimation, using a standard methodology. Our findings show that it is potentially important to go beyond the CAPM for energy utilities. They represent an invitation to further use the advances in the literature on the cross-section of returns to better understand their equity rate of return.

The rest of the paper is divided as follows. The next section presents our sample of energy utilities and reference portfolios. The third, fourth and fifth sections examine the risk premium estimates with the CAPM, the Fama-French model and the Adjusted CAPM, respectively. Each section provides an overview of the model, presents its empirical estimation and results, and discusses the implications of our findings. The last section concludes.

2. Sample Selection and Descriptive Statistics

This section examines the sample of firms and portfolios for our estimation of the cost of equity of energy utilities. We focus on the gas distribution sector to present complete sector-level and firm-level results, but we also consider utilities indexes to ensure the robustness to other utilities. We provide Canadian and American results for comparison, as both energy markets are relatively integrated and investors might expect similar returns. We first discuss sample selection issues and then present descriptive statistics.

2.1. Sample Selection

Two important choices guide our sample selection process. First, we use monthly historical data in order to have sufficient data for estimating the parameters and test statistics, while avoiding the microstructure problems of the stock markets (low liquidity for numerous securities, non-synchronization of transactions, etc.) in higher frequency data.[3] We then annualized our results for convenience. Second, we emphasize reference portfolios (such as sector indexes) over individual firms. Reference portfolios reduce the potentially large noise (or diversifiable risk) in the stock market returns of individual firms. They allow for an increased statistical accuracy of the estimates, an advantage recognized since (at least) Fama and MacBeth (1973), and alleviate the problem that we do not observe the returns on utilities directly and must rely on utility holding companies.

To represent the gas distribution sector in Canada and the U.S., we use a published index and a constructed portfolio for each market. The independently-calculated published indexes are widely available and consider the entire history of firms having belonged to the gas distribution sector. The constructed portfolios use the most relevant firms at present in the gas distribution or energy utility sector. The data collection also allows an examination of the robustness of our results at the firm level. The resulting four gas distribution reference portfolios are described below:

- *DJ_GasDi*: A Canadian gas distribution index published by Dow Jones, i.e. the "Dow Jones Canada Gas Distribution Index." The firms in the index are weighted by their market value. Monthly returns (180) are available from January 1992 to December 2006;
- *CAindex*: An equally-weighted constructed portfolio formed of 13 Canadian energy utilities, most with activities that are related to the gas distribution sector, i.e. ATCO Ltd., Algonquin Power Income Fund, Canadian Utilities Limited, EPCOR Power, Emera Incorporated, Enbridge Inc., Fort Chicago Energy Partners, Fortis Inc., Gaz Métro Limited Partnership, Northland Power Income Fund, Pacific Northern Gas, TransAlta Corporation and TransCanada Pipelines.[4] Monthly returns (263) are available from February 1985 to December 2006;
- *DJ_GasUS*: A U.S. gas distribution index published by Dow Jones, i.e. the "Dow Jones US Gas Distribution Index." The firms in the index are weighted by their market value. Monthly returns (180) are available from January 1992 to December 2006;
- *USindex*: An equally-weighted constructed portfolio formed of nine U.S. firms whose activities are heavily concentrated in local gas distribution, i.e. AGL Resources Inc., Atmos Energy Corp., Laclede Group, New Jersey Resources Corp., Northwest Natural Gas Co., Piedmont Natural Gas Co., South Jersey Industries, Southwest Gas Corp. and WGL Holdings Inc. Monthly returns (407) are available from February 1973 to December 2006.

[3] See Fowler, Rorke and Jog (1979, 1980) for an analysis of these problems in the Canadian stock markets.

[4] We also considered AltaGas Utility Group, Enbridge Income Fund, Westcoast Energy, Nova Scotia Power and Energy Savings Income Fund. We did not retain the first four because they had a returns history of less than 60 months. We eliminated the last one because it is a gas broker and its average monthly return of more than 3% was a statistical outlier. Our results are robust to variations in the formation of the CAindex portfolio, like the inclusion of these five firms or the exclusion of income funds and limited partnerships.

To confirm the validity of our analysis to other energy utilities, we also consider four utilities reference portfolios, which consist of the utilities sector indexes described below:

- *DJ_Util*: A Canadian utilities index published by Dow Jones, i.e. the "Dow Jones Canada Utilities Index." The firms in the index are weighted by their market value. Monthly returns (180) are available from January 1992 to December 2006;
- *TSX_Util*: A Canadian utilities index published by S&P/TSX, i.e. the "S&P/TSX Utilities Index." The firms in the index are weighted by their market value. Monthly returns (228) are available from January 1988 to December 2006;
- *DJ_UtiUS*: A U.S. utilities index published by Dow Jones, i.e. the "Dow Jones US Utilities Index." The firms in the index are weighted by their market value. Monthly returns (180) are available from January 1992 to December 2006;
- *FF_Util*: A U.S. utilities index formed by Profs. Fama and French, or the University of Chicago and Dartmouth College, respectively. The firms in the index are weighted by their market value. Monthly returns (407) are available from February 1973 to December 2006.

Depending on their availability, the reference portfolio series have different starting dates. In our econometric estimation, we keep the maximum number of observations for each series. Fama and French (1997) find that such a choice results in costs of equity more precisely estimated and with more predictive ability than costs of equity obtained from rolling five-year estimation windows, a common choice in practice. The data are collected from the Canadian Financial Markets Research Center (CFMRC), Datastream and the web sites of Prof. French[5] and Dow Jones Indexes[6].

2.2. Descriptive Statistics

Descriptive statistics for the monthly returns are presented in Table 1. Panel A shows the results for the 13 Canadian energy utilities and their equally-weighted portfolio (CAindex). Panel B shows the results for nine U.S. gas distribution utilities and their equally-weighted portfolio (USindex). Panel C shows the statistics for Canadian and U.S. indexes for the utilities sector (DJ_Util, DJ_UtilUS, TSX_Util and FF_Util) and the gas distribution sub-sector (DJ_GasDi and DJ_GasUS).[7]

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[5] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.
[6] http://www.djindexes.com/mdsidx/index.cfm?event=showtotalMarketIndexData&perf=Historical%20Values
[7] The returns from August to November 2001 of the Dow Jones U.S. indexes are strongly influenced by the Enron debacle, which started with the resignation of its CEO, Jeffrey Skilling, on August 14, 2001 and ended with the bankruptcy of the company on December 2, 2001. During those four months, the DJ_GasUS and DJ_UtiUS indices lost 68.9% and 16.2% of their value, respectively. By comparison, the equally-weighted portfolio of U.S. gas distributors (USindex) gained 1.2% and the Fama-French utilities index (FF_Util) lost 6.2 %. In order to soften the impact of that statistical aberration (caused by an unprecedented fraud) on the estimation of the risk premium, the returns from August to November 2001 of DJ_GasUS and DJ_UtilUS are replaced by those of USindex and FF_Util, respectively.

TABLE 1
Descriptive Statistics of Monthly Returns

Variable	N	Mean	St Dev	Min	Max	Brief Description
Panel A: Canadian Energy Utilities						
ATCO	263	0.013	0.067	-0.301	0.279	ATCO Ltd.
Algonqui	108	0.009	0.054	-0.163	0.166	Algonquin Power Income Fund
CanUtili	263	0.012	0.043	-0.107	0.159	Canadian Utilities Limited
EPCOR	114	0.008	0.046	-0.201	0.108	EPCOR Power
Emera	143	0.009	0.043	-0.137	0.115	Emera Incorporated
Enbridge	263	0.011	0.054	-0.365	0.205	Enbridge Inc.
FortChic	107	0.009	0.054	-0.119	0.210	Fort Chicago Energy Partners
Fortis	228	0.013	0.041	-0.134	0.146	Fortis Inc.
GazMetro	166	0.010	0.037	-0.134	0.084	Gaz Métro Limited Partnerships
NorthPow	104	0.011	0.063	-0.202	0.205	Northland Power Income Fund
PacNorth	263	0.010	0.070	-0.400	0.507	Pacific Northern Gas
TransAlt	263	0.009	0.048	-0.217	0.188	TransAlta Corporation
TransCan	258	0.008	0.054	-0.214	0.254	TransCanada Pipelines
CAindex	263	0.010	0.031	-0.130	0.087	Equally-weighted portfolio
Panel B: U.S. Gas Distribution Utilities						
AGL_Res	407	0.013	0.052	-0.138	0.253	AGL Resources Inc.
Atmos	277	0.013	0.063	-0.302	0.269	Atmos Energy Corp.
Laclede	407	0.012	0.056	-0.148	0.374	Laclede Group
NJ_Res	407	0.013	0.063	-0.171	0.577	New Jersey Resources Corp.
Northwes	407	0.012	0.060	-0.236	0.274	Northwest Natural Gas Co.
Piedmont	407	0.013	0.059	-0.188	0.315	Piedmont Natural Gas Co.
SouthJer	407	0.012	0.058	-0.194	0.486	South Jersey Industries
Southwes	407	0.011	0.070	-0.304	0.234	Southwest Gas Corp.
WGL_Hold	407	0.012	0.071	-0.232	0.807	WGL Holdings Inc.
USindex	407	0.012	0.041	-0.121	0.338	Equally-weighted portfolio
Panel C: Sector Indexes						
TSX_Util	228	0.010	0.037	-0.101	0.114	S&P/TSX Utilities Index
DJ_GasDi	180	0.012	0.043	-0.139	0.137	Dow Jones Canada Gas Distribution Index
DJ_Util	180	0.007	0.036	-0.139	0.101	Dow Jones Canada Utilities Index
DJ_GasUS	180	0.012	0.039	-0.120	0.143	Dow Jones US Gas Distribution Index
DJ_UtiUS	180	0.009	0.042	-0.127	0.136	Dow Jones US Utilities Index
FF_Util	407	0.010	0.041	-0.123	0.188	Fama-French US Utilities Index

NOTES: This table presents descriptive statistics on the monthly returns of 13 Canadian utilities and their equally-weighted portfolio (CAindex) in Panel A, of nine U.S. gas distribution utilities and their equally-weighted portfolio (USindex) in Panel B, and on selected utilities sector indexes in Panel C. The columns labelled N, Mean, St Dev, Min and Max correspond respectively to the number of observations, the mean, the standard deviation, the minimum value and the maximum value. The column labelled Brief Description gives the full name of the utility holding companies or the utilities sector indexes.

For the Canadian energy utilities, the monthly average return of all 13 firms is 1.0% with a standard deviation of 3.1%. The Dow Jones Canada Gas Distribution Index, the Dow Jones Canada Utilities Index and the S&P/TSX Utilities Index have mean returns of 1.2%, 0.7% and 1.0%, respectively. The monthly average return of the nine U.S. gas distribution utilities is 1.2% with a standard deviation of 4.1%. The Dow Jones US Gas Distribution Index, the Dow Jones US Utilities Index and the Fama-French U.S. Utilities Index show mean returns of 1.2%, 0.9% and 1.0%, respectively. Correlations between the four gas distribution reference portfolios (not tabulated) are between 0.29 and 0.80. These correlations indicate that the portfolios show some commonality, but are not perfect substitutes. We next start our analysis of the equity risk premium models.

3. EQUITY RISK PREMIUM WITH THE CAPM

This section examines the use of the Capital Asset Pricing Model (CAPM) for estimating the rate of return for energy utilities. The CAPM is the model the most often associated with the Equity Risk Premium method that is the basis of the rate adjustment formulas of regulatory bodies. We first present the model and its relevant literature. Then we estimate the model for our sample of energy utilities. Finally, we discuss the implications of our findings.

3.1. Model and Literature

The CAPM is a model proposed by Sharpe (1964) and Lintner (1965) in which the expected equity return or cost of equity for a gas utility is given by

$$E(R_{GAS}) = R_f + \beta \times \lambda_m ,$$

where R_f is the risk-free rate, β is the firm's beta or sensitivity to the market returns and λ_m is the market risk premium. In this model, a higher beta results in a higher risk premium.

The CAPM is the best known model of expected return. In spite of its undeniable importance in the field of finance, it has long been rejected by numerous empirical tests in the academic literature. The empirical rejections start with the first tests (Black, Jensen and Scholes, 1972, Fama and MacBeth, 1973, and Blume and Friend, 1973) that find that the relation between beta and average return is flatter than predicted by the model. They continue with the discovery of numerous "anomalies" (like the price-to-earnings effect of Basu, 1977, the size effect of Banz, 1981, etc.). Finally, in the 1990s, based on high-impact articles, including Fama and French (1992, 1993, 1996a and 1996b), Jegadeesh and Titman (1993) and Jagannathan and Wang (1996), the academic profession reaches a relative consensus that the CAPM is not valid empirically. In Canada, like elsewhere in the world, the literature reaches similar conclusions (see Morin, 1980, Bartholdy, 1993, Bourgeois and Lussier, 1994, Elfakhani, Lockwood and Zaher, 1998, L'Her, Masmoudi and Suret, 2002, 2004.).

A complete review of the literature on the problems of the CAPM is beyond the scope of this paper. It is nevertheless important to point out the two characteristics of energy utilities that suggest the CAPM might be problematic in estimating their equity return. First, energy utilities have typically low betas, significantly below one. Second, they are known as value investments, in the sense that they have high earnings-to-price, book-to-market, cash flows-to-price or dividend-to-price ratios. In a summary article requested for a symposium on the 40^{th} anniversary of the CAPM, Fama and French (2004) highlight the result of using the model to estimate the cost of equity capital for firms with these two characteristics:

> "As a result, CAPM estimates of the cost of equity for high beta stocks are too high (relative to historical average returns) and estimates for low beta stocks are too low (Friend and Blume, 1970). Similarly, if the high average returns on value stocks (with

> high book-to-market ratios) imply high expected returns, CAPM cost of equity estimates for such stocks are too low."[8]

As Fama and French (2004) indicate, the low-beta and value characteristics of energy utilities will probably lead the CAPM to estimate a rate of return that is too low. We next examine whether this undervaluation in fact exists in our sample of reference portfolios and utilities.

3.2. Risk Premium Estimates

This section empirically estimates the risk premium with the CAPM using the previously described Canadian and U.S. monthly data.[9] More specifically, we estimate the model using the time-series regression approach pioneered by Black, Jensen and Scholes (1972) with the following equation:

$$R_{GAS,t} - R_{f,t} = \alpha_{GAS} + \beta \times \lambda_{m,t} + \varepsilon_{GAS,t},$$

where $\lambda_{m,t} = R_{m,t} - R_{f,t}$ is the return on the market portfolio in excess of the risk-free return and $\varepsilon_{GAS,t}$ is the mean-zero regression error, at time *t*. In this equation, the CAPM predicts that the alpha (or intercept) is zero ($\alpha_{GAS} = 0$) and the risk premium is $E(R_{GAS,t} - R_{f,t}) = \beta \times E(\lambda_{m,t})$. An alpha different from zero can be interpreted as the risk premium error of the CAPM (see Pastor and Stambaugh, 1999). A positive alpha indicates the CAPM does not prescribe a large enough risk premium compared to its historical value (an underestimation), whereas a negative alpha indicates the CAPM prescribes a risk premium that is too large (an overestimation). It is therefore possible to determine the CAPM risk premium error for energy utilities based on the estimates of the alpha.[10]

We use Hansen's (1982) Generalized Method of Moments technique in order to estimate jointly the parameters α_{GAS} and β of the model and the market risk premium $E(\lambda_{m,t})$. As Cochrane (2001, Section 12.1) shows, this method has the necessary flexibility to correct the results for possible econometric problems in the

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[8] Fama and French (2004), p. 43-44.

[9] Our focus is on the estimation of the equity risk premium for energy utilities. To obtain their full cost of equity, we would need to add an appropriate risk-free rate, which could depend on the circumstances. For example, one common choice advocates adding to their equity risk premium the yield on a long-term government bond. But other choices for an appropriate risk-free rate are possible.

[10] The time series regression approach is commonly used when the model factors are returns. Cochrane (2001, Chapter 12) emphasizes that the approach implicitly imposes the restriction that the factors (chosen to fully represent the cross section of returns in the modeling) should be priced correctly in the estimation. While there are other ways to estimate a model like the CAPM, one advantage of the times series regression approach is that it can be easily applied to a restricted set of assets (like energy utilities) as the cross-sectional variations in asset returns are already captured by the correct pricing of the traded factors. Cochrane (2001, Chapter 12) also shows that the approach is identical to a Generalized Least Square cross-sectional regression approach.

data.[11] We take the monthly returns on portfolios of all listed securities weighted by their market value for the market portfolio returns and on the Treasury bills for the risk-free returns.[12] The annualized mean market risk premiums are 5.2% for Canada from February 1985 to December 2006 and 6.0% for the U.S. from February 1973 to December 2006.

Table 2 shows the results of the regressions using each of the four gas distribution reference portfolios. The estimates of the annualized risk premium error (or annualized α_{GAS}), the beta β and the risk premium $\beta \times E(\lambda_{m,t})$ are presented in Panels A, B and C, respectively. For each estimate, the table also shows its standard error, t-statistic and associated p-value.

TABLE 2
CAPM Risk Premium Estimates for the Gas Distribution Reference Portfolios

Portfolio	Estimate	SE	t-stat	Prob > |t|
Panel A: Risk Premium Error (Alpha)				
DJ_GasDi	8.43	3.79	2.22	0.028
CAindex	4.52	2.33	1.94	0.053
DJ_GasUS	7.39	3.34	2.21	0.028
USindex	6.23	1.95	3.19	0.002
Panel B: Beta				
DJ_GasDi	0.21	0.11	1.95	0.053
CAindex	0.34	0.07	4.60	<.0001
DJ_GasUS	0.37	0.09	4.16	<.0001
USindex	0.46	0.06	7.37	<.0001
Panel C: Risk Premium				
DJ_GasDi	1.66	1.28	1.30	0.195
CAindex	1.76	1.11	1.58	0.116
DJ_GasUS	2.74	1.46	1.87	0.063
USindex	2.72	1.33	2.04	0.042

NOTES: This table reports the results of the estimation of the CAPM for the gas distribution reference portfolios. Panels A to C look at the annualized risk premium error or alpha (in percent), the market beta and the annualized risk premium (in percent), respectively. The columns labelled Estimate, SE, t-stat and Prob > |t| give respectively the estimates, their standard errors, their t-statistics and their p-values. The four gas distribution reference portfolios and their sample are described in section 2 and table 1. The annualized mean market risk premiums for their corresponding sample period are 8.1% for DJ_GasDi, 5.2% for CAindex, 7.5% for DJ_GasUS and 6.0% for USindex.

The estimates in Panel A of Table 2 indicate that the risk premium errors are positive. Hence, the CAPM underestimates the risk premium for the gas distribution reference portfolios. The underestimation is not small – a minimum of 4.52% (for CAindex) and a maximum of 8.43% (for DJ_GasDi) – and is statistically greater than zero for all portfolios. Also, as expected, the underestimation comes with low

[11] All standard errors and statistical tests have been estimated using the Newey and West (1987) method, which takes account of the potential heteroscedasticity and autocorrelation in the errors of the statistical models.

[12] The data sources are CFMRC (until 2004) and Datastream (thereafter) for the Canadian returns and the web site of Prof. French for U.S. returns.

beta estimates, with values between 0.21 and 0.46 in Panel B. For example, for CAindex, the beta is 0.34 and the annualized risk premium predicted by the CAPM is 1.76%, an underestimation of the historical risk premium $\alpha_{GAS} = 4.52\%$.

To verify the underestimation is not an artifact of the utilization of the reference portfolios and is robust to other energy utilities, Figure 1 shows the risk premium errors for the utilities that make up the CAindex portfolio (Figure 1a), the gas distributors in the USindex portfolios (Figure 1b) and the four utilities reference portfolios (Figure 1c). Once again, the alphas are always positive, with values between 2.1% and 8.9% for the Canadian utilities, between 3.5% and 8.4% for the U.S. gas distributors, and between 2.1% and 5.0% for the utilities reference portfolios. The constantly positive and often significant errors support the notion that the CAPM might not be appropriate for determining the risk premium in the utilities sector.

FIGURE 1
Risk Premium Errors with the CAPM for Various Utilities

Figure 1a: Firms in the CAindex Portfolio

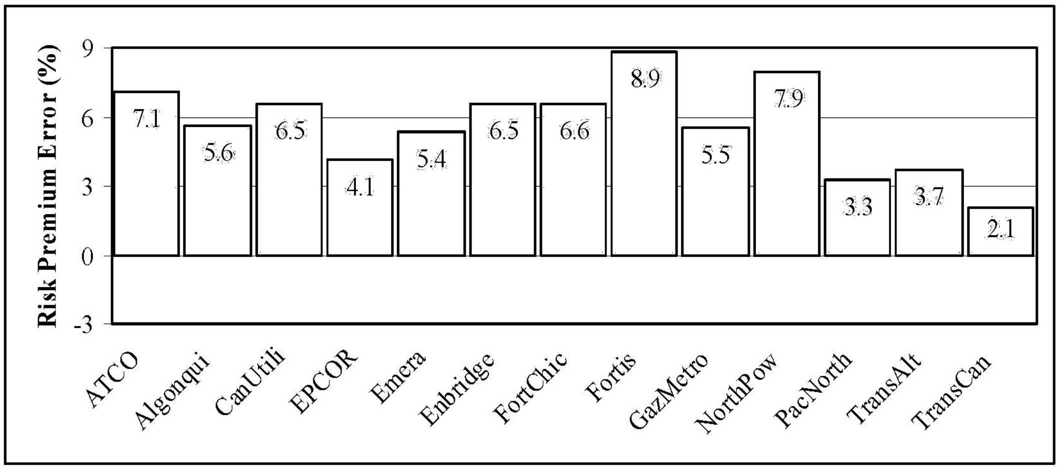


Figure 1b: Firms in the USindex Portfolio

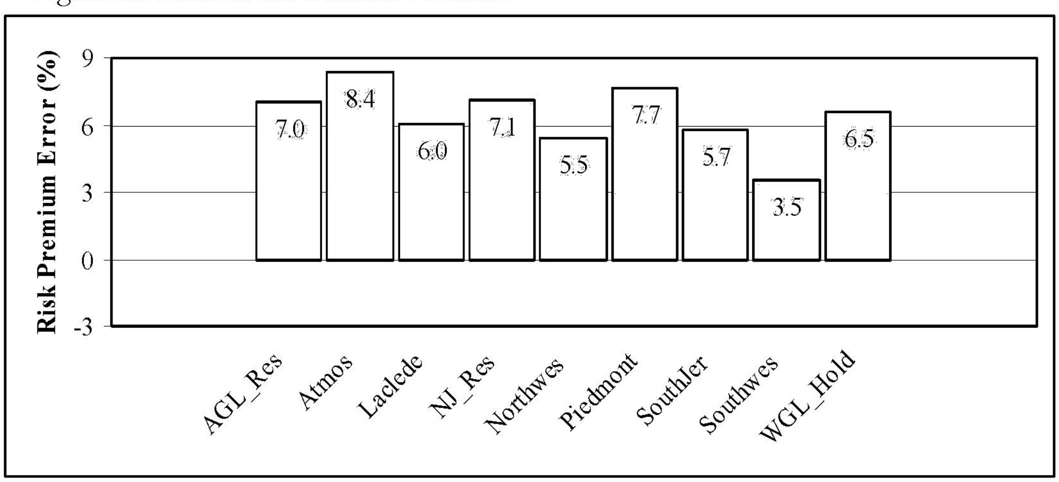
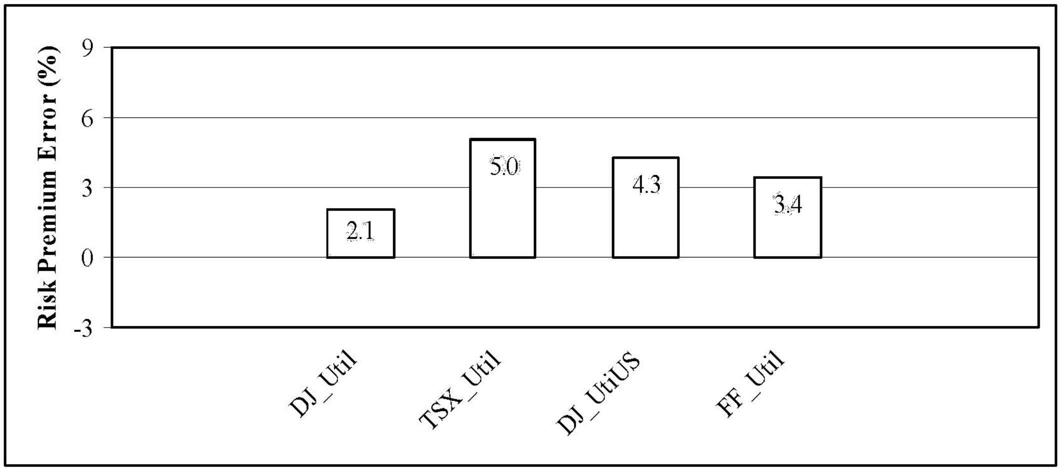


Figure 1c: Utilities Reference Portfolios



NOTES: This figure shows the annualized risk premium errors (or alphas) with the CAPM for the Canadian utilities in the CAindex portfolio (Figure 1a), the U.S. gas distributors in the USindex portfolio (Figure 1b) and the utilities reference portfolios (Figure 1c).

3.3. Discussion

Our results show that the CAPM underestimates the risk premium for the gas distribution sub-sector in particular and for the utilities sector in general. This finding is consistent with the empirical literature that finds that the CAPM tends to underestimate the risk premium of securities or sectors associated with low-beta, value and small-cap investments. In the terminology of asset pricing, the returns on energy utilities are "anomalous" with respect to the CAPM. As the application of the model would not be sensible in evaluating the performance of value-type mutual funds, given the related anomaly, it could be unwarranted in evaluating the cost of equity for energy utilities.

While the magnitude of the underestimation for the utilities is large, it is not unexpected. Fama and French (2004) review the evidence on the large CAPM literature for the *full cross-section* of equity returns. Their figures 2 and 3, in particular, illustrate well the findings for portfolios of stocks formed on their beta and their book-to-market ratio value indicator, respectively. In the cross-section of all stock returns, their figure 2 show visually that the CAPM underestimation is about 3% for the lowest beta portfolio (a beta of about 0.6), while its overestimation is about 3% for the highest beta portfolio (a beta of about 1.8). Their figure 3 indicates that the CAPM underestimation is about 5% for the highest book-to-market ratio portfolio, while its overestimation is about 2% for the lowest book-to-market ratio portfolio. As energy utilities are low-beta and value-oriented stocks, our estimates of the CAPM underestimation for this segment are consistent with the evidence from the full cross-section of equity returns.

Our results are related to numerous studies documenting that the CAPM alphas are different from zero. As a consequence of these rejections, finance researchers have considered various models that generalized the CAPM as well as various empirical improvements to the estimates of the CAPM. Based on this literature, we explore two alternative ways of estimating the risk premium of energy utilities in the next two sections.

4. EQUITY RISK PREMIUM WITH THE FAMA-FRENCH MODEL

The CAPM claims that a single factor, the market portfolio return, can explain expected returns. The most natural extension is to take multiple factors into account. Clearly, if factors other than the market return have positive risk premiums that contribute to explaining expected returns, then the inclusion of those factors should provide a better estimate of the risk premium and potentially eliminate the CAPM errors (see Merton, 1973, and Ross, 1976, for formal theoretical justifications). This section considers one of the most common generalization of the CAPM, a multifactor model by Fama and French (1993). We first describe the model and then use it to estimate the risk premium of energy utilities. We finally discuss the interpretation of our findings.

4.1. Model and Literature

The Fama-French model is a three-factor model developed to capture the anomalous returns associated with small-cap, value and growth portfolios by including risk premiums for size and value. For a gas utility, the expected equity return is given by

$$E(R_{GAS}) = R_f + \beta \times \lambda_m + \beta_{SIZE} \times \lambda_{SIZE} + \beta_{VALUE} \times \lambda_{VALUE},$$

where R_f is the risk-free rate, β, β_{SIZE} and β_{VALUE} are respectively the firm's market, size and value betas, and λ_m, λ_{SIZE} and λ_{VALUE} are respectively the market, size and value risk premiums. The three betas represent sensitivities to the three sources of risk, and the higher are their values, the higher is a firm's risk premium. In cases when the size and value risk factors are not relevant, then the Fama-French model reduces to the CAPM. Theoretical justifications for the size and value premiums are provided by Berk, Green and Naik (1999), Gomez, Kogan and Zhang (2003), and Carlson, Fisher and Giammarino (2004). Fama and French (1993, 1996a) are the two of the most influential empirical tests of the model.

Like the CAPM, the Fama-French model has been used in applications ranging from performance measurement to abnormal return estimation and asset valuation. For the calculation of the cost of equity capital, the model is studied by, among others, Schink and Bower (1994), Fama and French (1997), and Pastor and Stambaugh (1999). It has also proven to be relevant for explaining stock market returns in most countries where it has been examined. For example, in Canada, the model is validated by Elfakhani, Lockwood and Zaher (1998) and L'Her, Masmoudi and Suret (2002). Given that energy utilities are associated with value investments, the Fama-French model has the potential to improve the estimation of their rates of returns. We next assess this possibility for our sample of reference portfolios and utilities.

4.2. Risk Premium Estimates

The risk premium with the Fama-French model is estimated with a methodology that is similar to the one followed for the CAPM using the following equation:

$$R_{GAS,t} - R_{f,t} = \alpha_{GAS}^{FF} + \beta \times \lambda_{m,t} + \beta_{SIZE} \times \lambda_{SIZE,t} + \beta_{VALUE} \times \lambda_{VALUE,t} + \upsilon_{GAS,t},$$

where $\lambda_{m,t} = R_{m,t} - R_{f,t}$ is the return on the market portfolio in excess of the risk-free return, $\lambda_{SIZE,t} = R_{SMALL,t} - R_{LARGE,t}$ is the return on a small-cap portfolio in excess of the return on a large-cap portfolio, $\lambda_{VALUE,t} = R_{VALUE,t} - R_{GROWTH,t}$ is the return on a value portfolio in excess of the return on a growth portfolio and $\upsilon_{GAS,t}$ is the mean-zero regression error, at time *t*. The alpha α_{GAS}^{FF} is still interpreted as the risk premium error. The three beta parameters give the sensitivities to the market, size and value factors. Finally, $\beta \times E(\lambda_{m,t}) + \beta_{SIZE} \times E(\lambda_{SIZE,t}) + \beta_{VALUE} \times E(\lambda_{VALUE,t})$ represents the risk premium from the Fama-French model.

The data for the market portfolio returns and the risk-free returns are the same used in the CAPM estimation. For the Canadian regressions, the small-cap portfolio returns are from a portfolio of all listed securities weighted equally whereas the large-cap portfolio returns are from a portfolio of all listed securities weighted by their market value.[13] The value and growth portfolios are determined from the earnings-to-price ratio. Specifically, the value (growth) portfolio contains firms having an earnings/price ratio in the highest (lowest) 30%.[14] For U.S. regressions, the size and value premiums are the Fama and French (1993, 1996a) SMB and HML variables, which are computed from market capitalization (size) and book-to-market ratio (value).[15] The annualized mean size and value risk premiums are respectively 8.9% and 6.4% for Canada from February 1985 to December 2006 and 2.7% and 6.0% for the U.S. from February 1973 to December 2006.

Table 3 presents the results of the estimates of the coefficients and the risk premium with the Fama-French model for the four gas distribution reference portfolios previously described. Panel A shows that the annualized risk premium errors are still positive for the four portfolios, ranging from 0.31% (for USindex) to 4.45% (for DJ_GasDi), but the underestimation is now statistically negligible. Panel D confirms that the inclusion of the value risk premium is instrumental in the reduction of the errors. The value betas are highly significant, with values between 0.30 and 0.71. The size betas (Panel C) are low and often not statistically different from zero, whereas the market betas (Panel B) are 0.54 on average. The estimated risk premiums vary between 4.23% and 8.83%.

[13] These indexes are taken from CFMRC for returns up to 2004 and then completed by the returns of the S&P/TSX Composite Index and the MSCI Barra Smallcap Index, respectively.

[14] Data come from the web site of Prof. French, who also provides specific instructions on the composition of the portfolios. The site gives returns for value and growth portfolios based on four indicators – earnings-to-price, book-to-market, cash flows-to-price and dividend-to-price. Fama and French (1996a) show that these indicators contain the same information about expected returns. Fama and French (1998) confirm the relevance of these indicators in explaining the returns in 12 major international financial markets and emerging financial markets. We chose the earnings-to-price indicator because it is more effective in capturing the premium of value securities compared to growth securities in Canada (see Bartholdy, 1993, and Bourgeois and Lussier, 1994). The indicator book-to-market is less effective in Canada because the value effect is mainly concentrated in more extreme portfolios (highest and lowest 10%) than in those available on the site (see L'Her, Masmoudi and Suret, 2002).

[15] Data again come from the web site of Prof. French. Detailed instructions on the composition of the SMB and HML variables are also provided.

TABLE 3
Fama-French Risk Premium Estimates for the Gas Distribution Reference Portfolios

Portfolio	Estimate	SE	t-stat	Prob > |t|
Panel A: Risk Premium Error (Alpha)				
DJ_GasDi	4.45	3.11	1.43	0.155
CAindex	2.04	1.85	1.11	0.270
DJ_GasUS	1.31	3.01	0.43	0.665
USindex	0.31	1.80	0.17	0.863
Panel B: Beta				
DJ_GasDi	0.41	0.08	5.06	<.0001
CAindex	0.48	0.05	10.38	<.0001
DJ_GasUS	0.63	0.07	9.64	<.0001
USindex	0.64	0.06	11.18	<.0001
Panel C: Size Beta				
DJ_GasDi	-0.01	0.08	-0.11	0.912
CAindex	-0.02	0.05	-0.51	0.613
DJ_GasUS	0.00	0.09	0.04	0.971
USindex	0.20	0.07	2.9	0.004
Panel D: Value Beta				
DJ_GasDi	0.33	0.06	5.12	<.0001
CAindex	0.30	0.04	7.64	<.0001
DJ_GasUS	0.59	0.13	4.41	<.0001
USindex	0.71	0.10	7.21	<.0001
Panel E: Risk Premium				
DJ_GasDi	5.64	1.78	3.17	0.002
CAindex	4.23	1.52	2.78	0.006
DJ_GasUS	8.83	2.32	3.81	0.000
USindex	8.64	2.16	4	<.0001

NOTES: This table reports the results of the estimation of the Fama-French model for the gas distribution reference portfolios. Panels A to E look at the annualized risk premium error or alpha (in percent), the market beta, the size beta, the value beta and the annualized risk premium (in percent), respectively. The columns labelled Estimate, SE, t-stat and Prob > |t| give respectively the estimates, their standard errors, their t-statistics and their p-values. The four gas distribution reference portfolios and their sample are described in section 2 and table 1. The annualized mean market risk premiums for their corresponding sample period are 8.1% for DJ_GasDi, 5.2% for CAindex, 7.5% for DJ_GasUS and 6.0% for USindex. The annualized mean size risk premiums for their corresponding sample period are 12.4% for DJ_GasDi, 8.9% for CAindex, 2.7% for DJ_GasUS and 2.7% for USindex. The annualized mean value risk premiums for their corresponding sample period are 7.4% for DJ_GasDi, 6.4% for CAindex, 6.9% for DJ_GasUS and 6.0% for USindex.

Figure 2 compares the Fama-French and CAPM results. Figure 2a illustrates the risk premium errors of the two models, while Figure 2b shows their explanatory power given by the adjusted R^2. The errors have substantially fallen with the Fama-French model for all reference portfolios. Furthermore, the Fama-French model explains a much larger proportion of the variation in the reference portfolio returns.

FIGURE 2
Comparison of the Fama-French and CAPM Results

Figure 2a: Risk Premium Errors

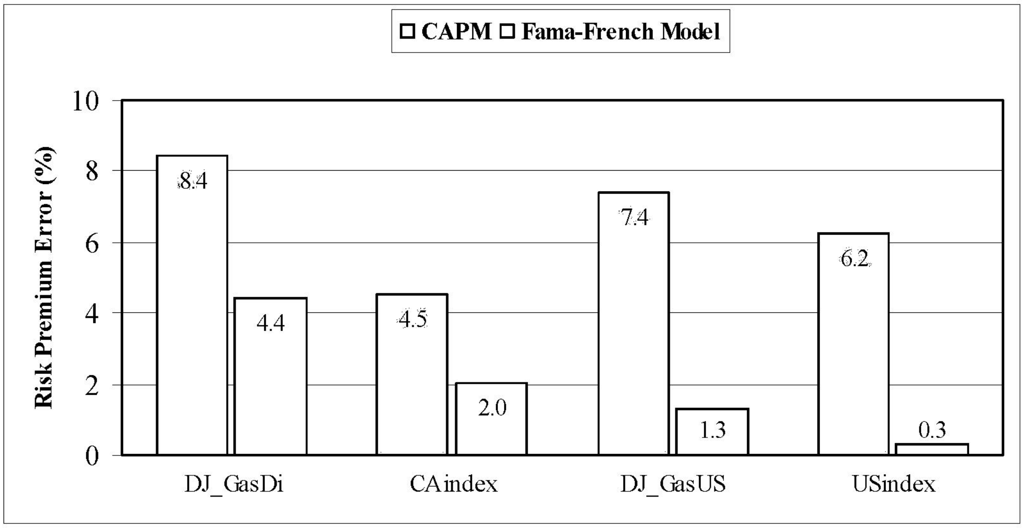
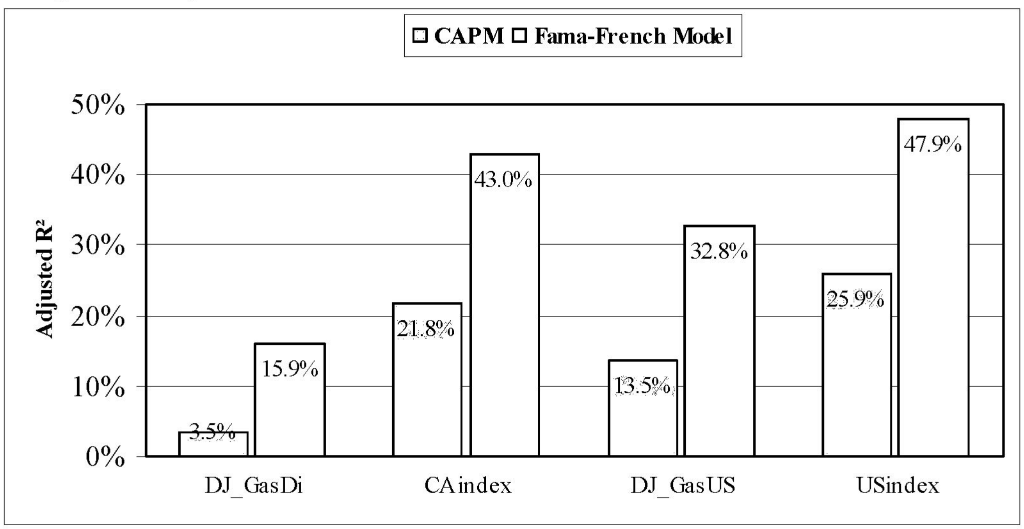


Figure 2b: Adjusted R²s



NOTES: This figure compares the results of the CAPM (gray bars) and the Fama-French model (white bars) in terms of annualized risk premium errors (or alphas) (Figure 2a) and adjusted R^2 (Figure 2b) for the gas distribution reference portfolios.

Figures 3 and 4 present the risk premium errors and the value betas, respectively, for the utilities that make up the CAindex portfolios (Figures 3a and 4a), the gas distributors in the USindex portfolios (Figures 3b and 4b) and the four utilities reference portfolios (Figures 3c and 4c). A comparison of Figure 3 with Figure 1 shows that the risk premium errors have decreased in all cases. None of the errors are now significantly different from zero. Figure 4 confirms that the reductions in the risk premium errors are caused by the inclusion of the value risk premium. All value betas are greater than 0.23 and statistically significant. For example, the TSX_Util portfolio has a value beta of 0.41 that contributes to reduce its risk premium error from 5.0% with the CAPM to 0.7% with the Fama-French model.

FIGURE 3
Risk Premium Errors with the Fama-French Model for Various Utilities

Figure 3a: Firms in the CAindex Portfolio

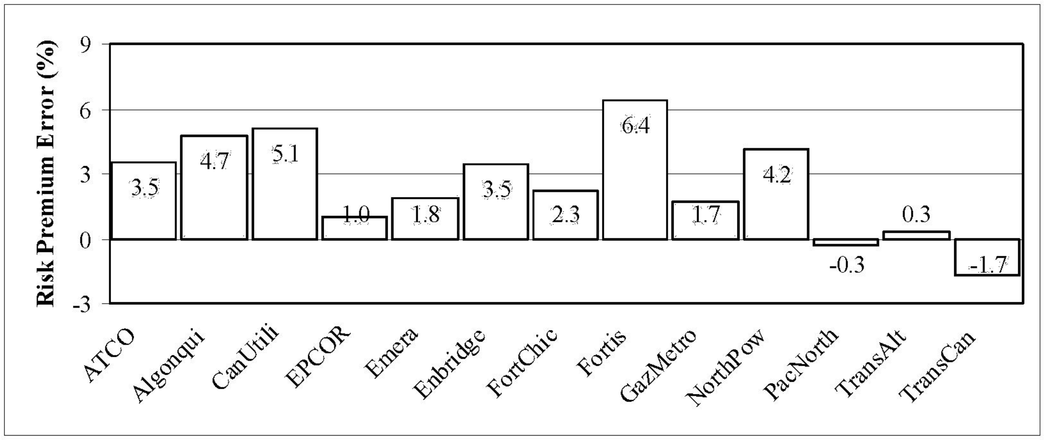


Figure 3b: Firms in the USindex Portfolio

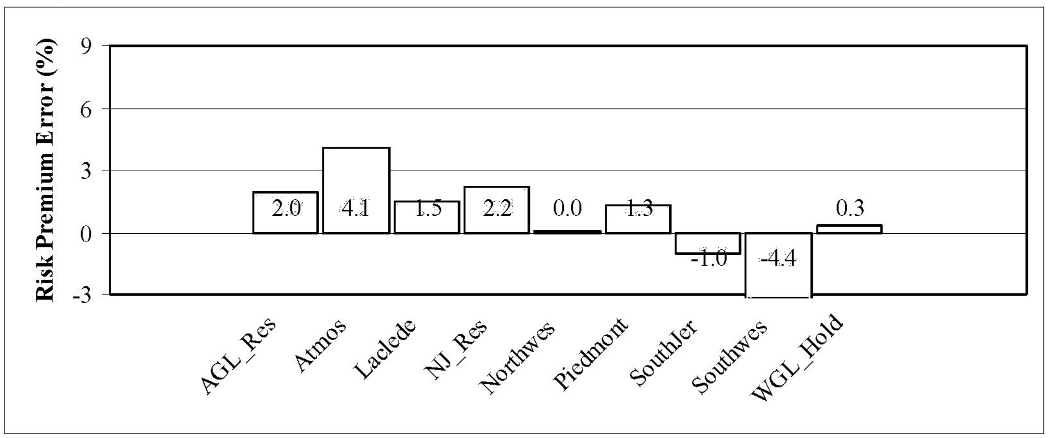
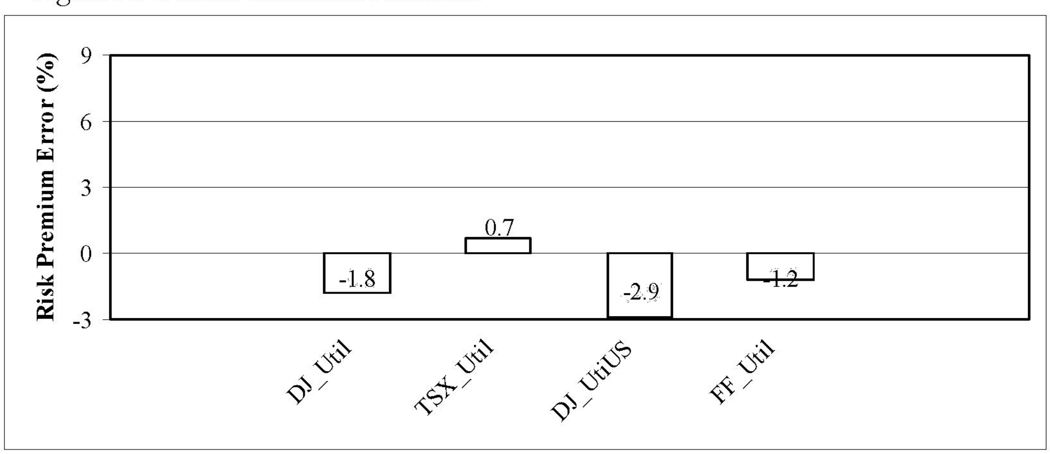


Figure 3c: Utilities Reference Portfolios



NOTES: This figure shows the annualized risk premium errors (or alphas) with the Fama-French model for the Canadian utilities in the CAindex portfolio (Figure 3a), the U.S. gas distributors in the USindex portfolio (Figure 3b) and the utilities reference portfolios (Figure 3c).

FIGURE 4
Value Betas for Various Utilities

Figure 4a: Firms in the CAindex Portfolio

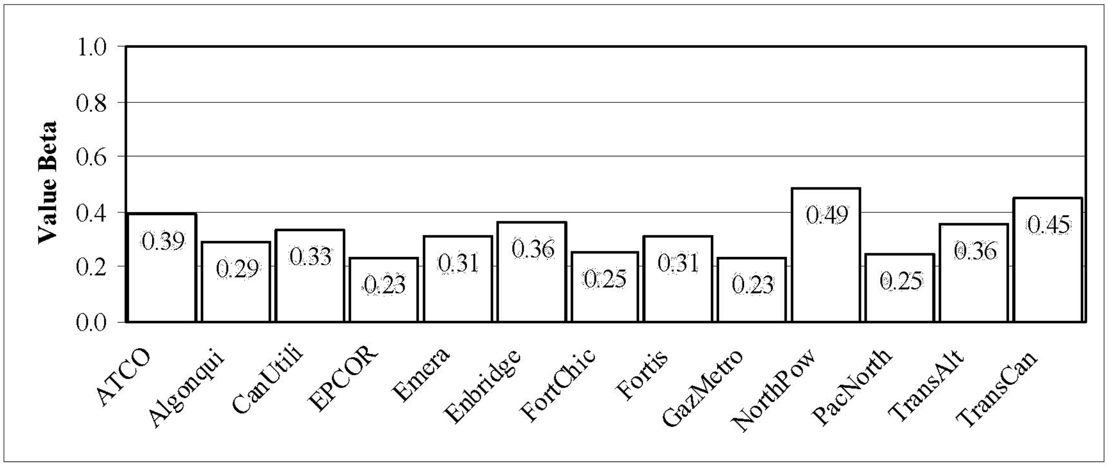


Figure 4b: Firms in the USindex Portfolio

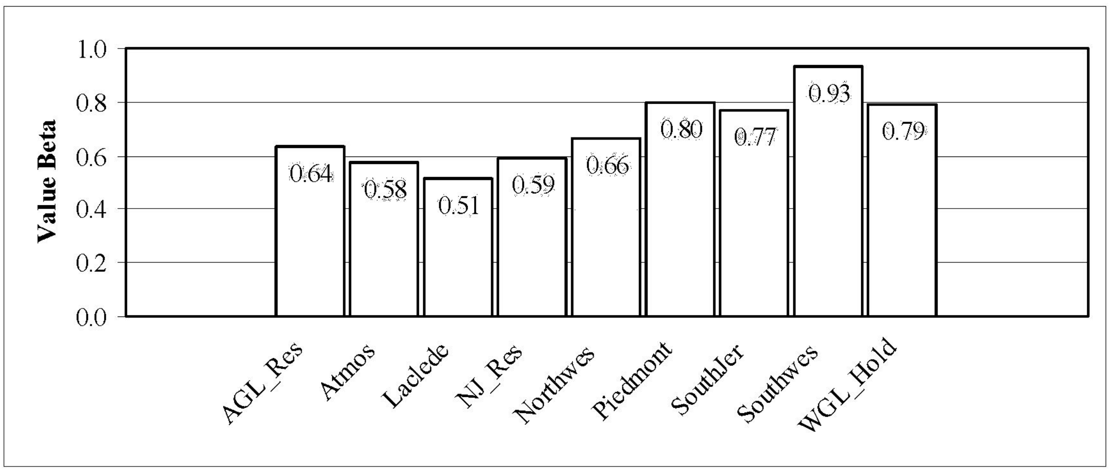
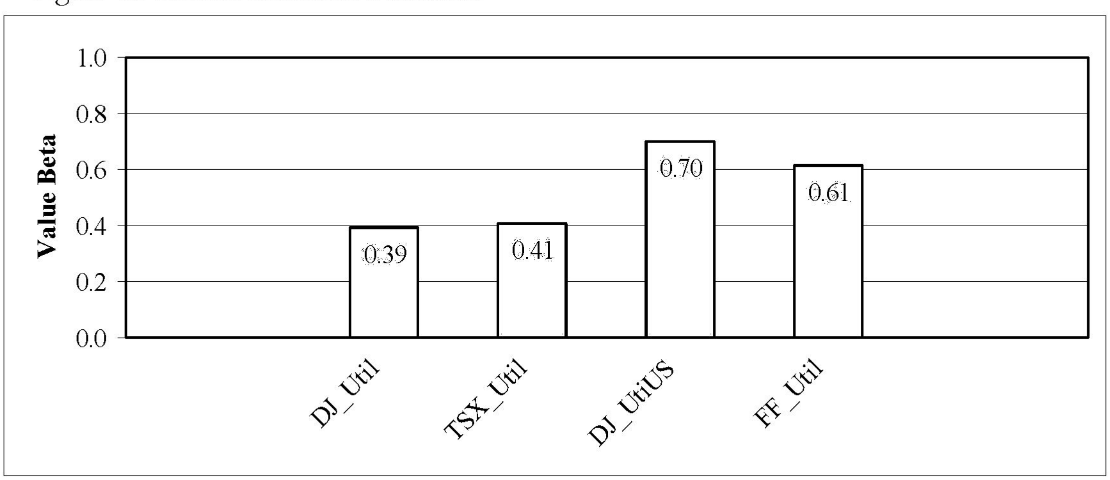


Figure 4c: Utilities Reference Portfolios



NOTES: This figure shows the value betas in the Fama-French model for the Canadian utilities in the CAindex portfolio (Figure 4a), the U.S. gas distributors in the USindex portfolio (Figure 4b) and the utilities reference portfolios (Figure 4c).

4.3. Discussion

Our results support the notion that the Fama-French model is well suited to estimate the risk premium for energy utilities, consistent with the findings of Schink and Bower (1994). We obtain lower risk premium errors with the Fama-French model than with the CAPM and significant value betas, similar to the results reported by Schink and Bower (1994), Fama and French (1997) and Pastor and Stambaugh (1999).

While the model is being increasingly considered in practice, an often mentioned limitation is that the economic interpretation of the size and value premiums is still under debate. On one side, starting with Fama and French (1993), the size and value factors are presented as part of a rational asset pricing model, where they reflect either state variables that predict investment opportunities following the theory of Merton (1973), or statistically useful variables to explain the returns following the theory of Ross (1976). On the other side, as first advocated by Lakonishok, Shleifer and Vishny (1994), the size and value factors are thought to be related to investors' irrationality in the sense that large-cap and growth stocks tend to be glamorized whereas small-cap and value stocks tend to be neglected. There is a vast literature on both sides of this debate.[16]

While the debate is important to improve our understanding of capital markets, Stein (1996) demonstrates that the theoretical interpretation of the model is not relevant to its application to determine the cost of capital. On one side, if the Fama-French model is rational, then the size and value factors capture true risks and should be accounted for in the risk premiums of energy utilities. On the other side, if the size and value factors are irrational, then the significant value betas of energy utilities indicate that they are neglected or undervalued firms. In this case, Stein (1996) shows that rational firms should not undertake a project that provides an expected return lower than the return estimated by the potentially irrational Fama-French model. They are better off in rejecting the project and simply buying back their own shares for which they expect an inflated future return because of the undervaluation. Thus, the potentially irrational Fama-French estimates serve as the appropriate hurdle rate for project investments. Hence, for both interpretations, the equity cost of capital of energy utilities generated by the Fama-French model is a useful guideline of a fair rate of return for regulators.

Arguably, the Fama-French model is one of the most widely used models of expected returns in the academic finance literature (Davis, 2006). Nevertheless, the literature on the cross-section of equity returns has identified numerous other factors that could be relevant in the multifactor approach. For examples, other influential factors include the labor income factor of Jagannathan and Wang (1996), the momentum factor of Jegadeesh and Titman (1993) and Carhart (1997), the liquidity factor of Pastor and Stambaugh (2003) and the idiosyncratic volatility factor of Ang *et al.* (2006, 2009). These advances in the literature on the cross-section of returns could eventually lead to a better understanding of the equity risk premium

[16] A third interpretation, following Lo and MacKinlay (1990) and Kothari, Shanken and Sloan (1995), is that the results of the Fama-French model are spurious, due to biases like data snooping or survivorship. However, the fact that similar size and value premiums have been found in countries outside the U.S. has rendered this explanation less appealing.

for energy utilities.[17] The next section looks at a second approach that goes beyond the CAPM to estimate the equity risk premium.

5. Equity Risk Premium with the Adjusted CAPM

This section considers two empirical adjustments to the CAPM estimates proposed in the academic literature to account for their deficiencies. We call the CAPM with the addition of the two modifications the "Adjusted CAPM". Unlike the CAPM and the Fama-French model, the Adjusted CAPM is not an equilibrium model of expected returns. It contains adjustments to the CAPM that are empirically justified in a context where the known difficulties of a theoretical model need to be lessened for improved estimation. We first introduce the Adjusted CAPM. Then we implement it to estimate the risk premium of energy utilities. We finally offer a brief discussion of our findings.

5.1. Model and Literature

The Adjusted CAPM is based on the CAPM but provides more realistic estimates of the rate of return by considering the empirical problems of the CAPM. More specifically, the Adjusted CAPM is a model in which the expected equity return of a gas utility is arrived at by

$$E(R_{GAS}) = R_f + \alpha_{GAS} \times (1 - \beta^{Adj}) + \beta^{Adj} \times \lambda_m .$$

Compared to the CAPM, this equation incorporates a modification to take into account that estimated betas can be adjusted for better predictive power and a modification to take account of the fact the alpha (risk premium error) is high for low-beta value-oriented firms in the CAPM.

The first modification originates from the works of Blume (1971, 1975). Blume (1971) examines historical portfolio betas over two consecutive periods and finds that the historical betas, from one period to another, regress towards one, the average of the market. He also shows that the historical betas adjusted towards one predict future betas better than unadjusted betas. Blume (1975) builds a historical beta adjustment model to capture the tendency to regress towards one. He discovers that the best adjustment is to use a beta equal to $0.343 + 0.677 \times \beta^{His}$, a finding that led to the concept of "adjusted beta". Merrill Lynch, which popularized the use of adjusted betas based on Blume (1975)'s results, advocates the adjustment $\beta^{Adj} = 0.333 + 0.667 \times \beta^{His}$. Merrill Lynch's adjusted beta, now widely used in practice, represents a weighted-average between the beta of the market and the historical beta, with a two-thirds weighting on the historical beta.

The second adjustment is initially proposed by Litzenberger, Ramaswamy and Sosin (1980), who consider solutions to the problem that the CAPM gives a cost of equity capital with a downward bias for low beta firms, as discussed in section 3.1. They note that one way of remedying the problem is to add a bias correction to the CAPM risk premium. To be effective, the correction must take account of the

[17] Some of the documented effects, like momentum, are short-lived. Hence, their related factor might be irrelevant for estimates of the cost of equity capital.

importance of the risk premium error and the level of the firm's beta because these two elements influence the magnitude of the problem. To do this for low beta securities, Litzenberger, Ramaswamy and Sosin (1980) propose the bias correction $\alpha_{GAS} \times (1-\beta)$. As desired, the correction increases with the risk premium error of the CAPM, and decreases with the beta. The correction is nil for a firm for which the CAPM already works well (when $\alpha_{GAS} = 0$) or for a firm having a beta of one, two cases where the CAPM produces a fair rate of return on average. Morin (2006, Section 6.3) presents an application of this adjustment in regulatory finance through a model he calls the empirical CAPM.

In summary, the two modifications incorporated in the Adjusted CAPM involve first using the adjusted beta instead of the historical beta and second including the bias correction in the risk premium calculation. Considering the documented usefulness of the two adjustments, the Adjusted CAPM has the potential to estimate a reasonable risk premium for the energy utilities.

5.2. Risk Premium Estimates

To compute the Adjusted CAPM estimates for our utilities, the starting point is the estimates of the CAPM of Section 3.2, given in Table 2. The beta estimates are now understood as the unadjusted historical betas β^{His}. The gas utility risk premium with the Adjusted CAPM can then be expressed as

$$\alpha_{GAS} \times \left(1-\beta^{Adj}\right) + \beta^{Adj} \times E\left(\lambda_{m,t}\right),$$

where $\beta^{Adj} = 0.333 + 0.667 \times \beta^{His}$. The Adjusted CAPM risk premium error is arrived at by

$$\alpha_{GAS}^{Adj} = E\left(R_{GAS,t} - R_{f,t}\right) - \left[\alpha_{GAS} \times \left(1-\beta^{Adj}\right) + \beta^{Adj} \times E\left(\lambda_{m,t}\right)\right].$$

Table 4 shows the Adjusted CAPM estimates using the four gas distribution reference portfolios. The estimates of the risk premium error α_{GAS}^{Adj}, the adjusted beta β^{Adj}, the bias correction $\alpha_{GAS} \times \left(1-\beta^{Adj}\right)$ and the risk premium are shown in Panels A, B, C and D, respectively. The risk premium errors are still positive for the four portfolios, with values ranging from 1.39% (for CAindex) to 2.89% (for USindex), but the underestimation is only significant for USindex. The reduction in errors comes from the use of adjusted betas, which are 0.56 on average, and the bias corrections, which are 2.96% on average. Lastly, the risk premiums vary between 4.88% and 8.27%, findings comparable to the estimates obtained with the Fama-French model.

TABLE 4
Adjusted CAPM Risk Premium Estimates
for the Gas Distribution Reference Portfolios

Portfolio	Estimate	SE	t-stat	Prob > |t|
Panel A: Risk Premium Error (Alpha)				
DJ_GasDi	1.82	2.00	0.91	0.365
CAindex	1.39	1.54	0.9	0.366
DJ_GasUS	2.68	1.97	1.36	0.176
USindex	2.89	1.37	2.11	0.035
Panel B: Adjusted Beta				
DJ_GasDi	0.47	0.07	6.69	<.0001
CAindex	0.56	0.05	11.38	<.0001
DJ_GasUS	0.58	0.06	9.84	<.0001
USindex	0.64	0.04	15.44	<.0001
Panel C: Bias Correction				
DJ_GasDi	4.46	2.28	1.96	0.052
CAindex	1.99	1.10	1.81	0.071
DJ_GasUS	3.12	1.61	1.94	0.054
USindex	2.26	0.77	2.94	0.004
Panel D: Risk Premium				
DJ_GasDi	8.27	2.71	3.05	0.003
CAindex	4.88	2.11	2.31	0.021
DJ_GasUS	7.45	2.52	2.96	0.004
USindex	6.05	1.89	3.21	0.002

NOTES: This table reports the results of the estimation of the Adjusted CAPM for the gas distribution reference portfolios. Panels A to D look at the annualized risk premium error or alpha (in percent), the adjusted market beta, the bias correction and the annualized risk premium (in percent), respectively. The columns labelled Estimate, SE, t-stat and Prob > |t| give respectively the estimates, their standard errors, their t-statistics and their p-values. The four gas distribution reference portfolios and their sample are described in section 2 and table 1. The annualized mean market risk premiums for their corresponding sample period are 8.1% for DJ_GasDi, 5.2% for CAindex, 7.5% for DJ_GasUS and 6.0% for USindex.

Figure 5 shows the risk premium errors for the utilities that make up the CAindex portfolios (Figure 5a), the gas distributors in the USindex portfolios (Figure 5b) and the four utilities reference portfolios (Figure 5c). The errors are generally insignificant and a comparison with Figure 1 indicates that they have decreased considerably for all portfolios. For example, for the TSX_Util portfolio, the error is down from 5.0% with the CAPM to 0.9% with the Adjusted CAPM.

FIGURE 5
Risk Premium Errors with the Adjusted CAPM for Various Utilities

Figure 5a: Firms in the CAindex Portfolio

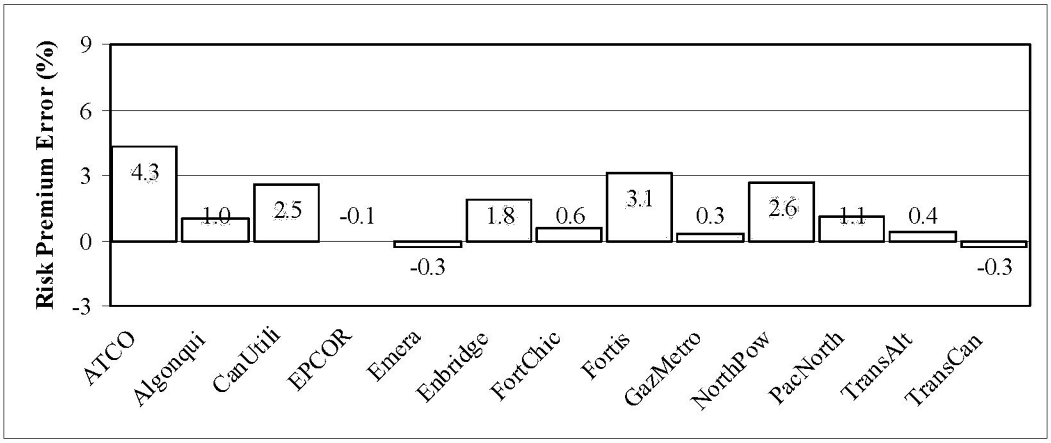


Figure 5b: Firms in the USindex Portfolio

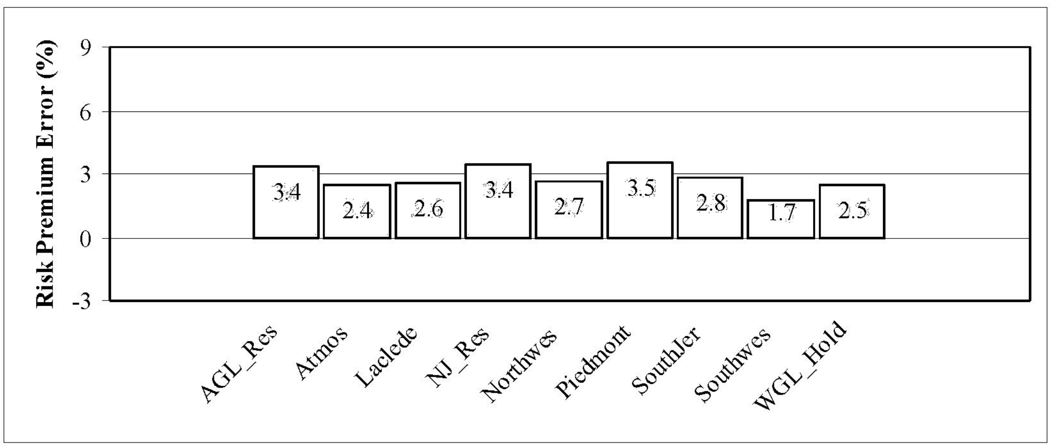
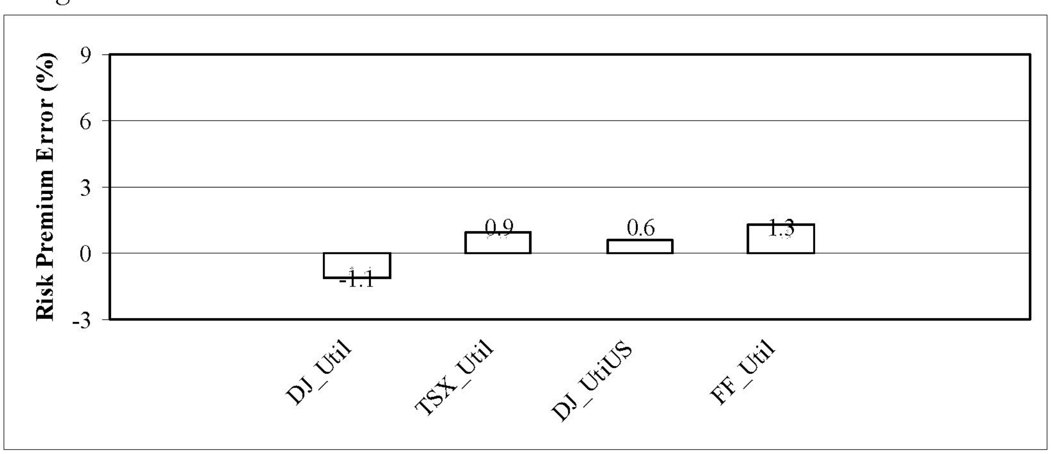


Figure 5c: Utilities Reference Portfolios



NOTES: This figure shows the annualized risk premium errors (or alphas) with the Adjusted CAPM for the Canadian utilities in the CAindex portfolio (Figure 5a), the U.S. gas distributors in the USindex portfolio (Figure 5b) and the utilities reference portfolios (Figure 5c).

5.3. Discussion

Our results support the validity of the Adjusted CAPM for determining the rate of return on energy utilities. While its risk premium estimates are in the same range as the Fama-French estimates, it arrives at its results from a different perspective. The Fama-French model advocates the use of additional risk factors to reduce the CAPM risk premium errors. The Adjusted CAPM, through its bias correction, effectively estimates the risk premium as a weighted-average of the CAPM risk premium and the realized historical risk premium, with a weighting of beta on the former.

The Adjusted CAPM thus recognizes that the CAPM is an imperfect model that can be improved with the information contained in the historical returns. Pastor and Stambaugh (1999) propose a similar strategy by demonstrating how to estimate the cost of equity by using Bayesian econometrics to incorporate the CAPM risk premium error (or alpha) in an optimal manner based on the priors of the evaluator. Consistent with our results, they also show evidence of higher costs of equity for energy utilities using their technique than using the CAPM alone.[18] As the Adjusted CAPM does not require additional risk factors like size and value, the model might be easier to interpret for regulators already familiar with the standard CAPM in their decisions.

6. Conclusion

It is difficult to overstate the importance of the evaluation of the expected rate of return in finance. For a firm's management group, the expected rate of return on equity (or the equity cost of capital) is central to its overall cost of capital, i.e. the rate used to determine which projects will be undertaken. For portfolio managers, the expected rate of return on equity is an essential ingredient in portfolio decisions. For regulatory bodies, the expected return on equity is the basis for determining the fair and reasonable rate of return of a regulated enterprise. This paper is interested in evaluating the rate of return in the context of regulated energy utilities.

The academic literature contains numerous theories for determining the expected rate of return on equity. As those theories are based on simplified assumptions of the complex world in which we live, they cannot be perfect. Even if the theoretical merit of the different models can be debated, the determination of the most valid approach to explain the financial markets really becomes an empirical question – it is necessary to answer the question "which theory best explains the information about actual returns?" This paper empirically examines the validity of the model the most often used in the rate adjustment formula of regulatory bodies, the CAPM, one of the most prominent academic alternatives, the Fama-French model, and a version of the CAPM modified to account for some of its empirical deficiencies, the Adjusted CAPM.

Our empirical results show that the risk premiums for energy utilities estimated with the CAPM are rejected as too low compared to the historical risk premiums.

[18] Pastor and Stambaugh (1999) obtain risk premiums that vary between the CAPM estimates, when they assume that there is zero prior uncertainty on the CAPM, and the historical estimates, when they assume that there is infinite prior uncertainty on the CAPM. Our bias correction corresponds approximately to a prior uncertainty on the CAPM between 3% and 6% in their setup.

The rejections are related to the well-documented CAPM underestimation of the average returns of low-beta firms and value firms. The Fama-French model and the Adjusted CAPM appear statistically better specified, as we cannot reject the hypothesis that their risk premium errors are equal to zero. They suggest equity risk premiums for gas distribution utilities between 4% and 8%. Overall, our findings demonstrate that models that go beyond the CAPM have the potential to improve the estimation of the cost of equity capital of energy utilities. They are thus interesting avenues for regulators looking to set fair and reasonable equity rates of return.

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MODERN REGULATORY FINANCE

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between the portfolio's annual rate of return and the government bond yield. To illustrate, let us say that the following hypothetical relationship between the risk premium and the portfolios' betas is obtained for the period 1931 – 2019:

$$\text{Risk Premium} = 4.21\% + (3.94\% \times \text{Beta})$$

Using the utility's beta of 0.60, for example, the risk premium for the hypothetical utility is:

$$4.21\% + (3.94\% \times 0.60) = 6.6\%$$

A long-term cost of equity capital estimate for the company is obtained by adding the risk premium of 6.6% to the current yield on long-term Treasury bonds or to the projected long-term yield implied by the closing prices on the Treasury bond futures contract traded on the Chicago Board of Trade. The latter measures the consensus long-term interest rate expectation of investors.[24] If the yield on long-term Treasury bonds is 4%, then the cost of equity implied by the observed risk-return relationship is 10.6%. A similar procedure could be developed based on the standard deviation of return rather than on beta as risk measure.

ECAPM And Double-Counting

As previously discussed in Chapter 4, Value Line and Bloomberg beta estimates are adjusted betas in keeping with investment practices and in keeping with the academic literature on the subject. The adjusted betas reported by *Value Line* give 2/3 weight to the "raw" or calculated beta and 1/3 weight to the market beta of 1.0. The definition of Adjusted Beta used by Value Line is as follows:

$$\text{Adjusted Beta} = 0.3333 + 0.6666 \times \text{Raw Beta}$$

Because of this adjustment, some critics of the ECAPM argue that the use of Value Line adjusted betas in the traditional CAPM amounts to using an ECAPM. This is incorrect. The use of adjusted betas in a CAPM analysis is not equivalent to the ECAPM. Betas are adjusted because of the regression tendency of betas to converge toward 1.0 over time. We have seen that numerous empirical studies have determined that the SML described by the CAPM formula at *any given moment in time* is not as steeply sloped as the predicted SML. The slope of the SML should

24. The average market forecasts of rates in the form of interest rate Treasury securities futures contracts data can be used as a proxy for the expected risk-free rate.

not be confused with beta. On that point, Eugene F. Brigham, finance professor emeritus and the author of many financial textbooks states:[25]

> *The slope of the SML (5% in Figure 6-16) reflects the degree of risk aversion in the economy: The greater the average investor's aversion to risk, then (a) the steeper the slope of the line, (b) the greater the risk premium for all stocks, and (c) the higher the required rate of return on all stocks. Students sometimes confuse beta with the slope of the SML. This is a mistake.*

The use of an adjusted beta by Value Line is correcting for a different problem than the ECAPM. The adjusted beta captures the fact that betas regress toward one over time. The ECAPM corrects for the fact that the CAPM under-predicts observed returns when beta is less than one and over-predicts observed returns when beta is greater than one.

In other words, the CAPM under-predicts actual returns for betas less than one which is a static relationship that exists at any point in time. The ECAPM corrects for the fact that the CAPM under-predicts observed returns when beta is less than one and over-predicts observed returns when beta is greater than one. Therefore, one adjustment captures a dynamic process, the other captures a static one. The two adjustments are not the same and there is no double-counting.

Another way of looking at it is that the Empirical CAPM and the use of adjusted betas comprise two separate features of asset pricing. Assuming *arguendo* a company's beta is estimated accurately, the CAPM will still understate the return for low-beta stocks. Furthermore, if a company's beta is understated, the Empirical CAPM will also understate the return for low-beta stocks. Both adjustments are necessary.

As shown on the graph of Figure 7-2, the Empirical CAPM is a return (vertical axis) adjustment and not a beta (horizontal axis) adjustment. The adjustment to beta corrects the estimate of the relative risk of the company, which is measured along the horizontal axis of the SML. The ECAPM adjusts the risk-return tradeoff (*i.e.*, the slope) in the SML, which is on the vertical axis. In other words, the expected return (measured on the vertical axis) for a given level of risk (measured on the horizontal axis) is different from the predictions of the theoretical CAPM. Getting the relative risk of the investment correct does not adjust for the slope of the SML, nor does adjusting the slope correct for errors in the estimation of relative risk. Moreover, the use of adjusted betas compensates for interest rate sensitivity of utility stocks not captured by unadjusted betas. Both adjustments are necessary.

While most of the academic research on the ECAPM did utilize raw betas rather than Value Line adjusted betas because the latter were not available over most of the time periods covered in these studies, Value Line adjusted betas were utilized in the later studies performed in Morin (2001). Moreover, an alpha range of 1% -

25. Brigham, Eugene F., *Financial Management – Theory and Practice*, 13th Ed. (The Dryden Press, 2011) 249.

On the CAPM Approach to the Estimation of A Public Utility's Cost of Equity Capital

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On the CAPM Approach to the Estimation of A Public Utility's Cost of Equity Capital

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I. Introduction

IN RECENT YEARS the Capital Asset Pricing Model (CAPM) has been used in several public utility rate cases to measure the cost of equity capital. In actual application, the cost of equity capital is frequently estimated as the annualized 90 day Treasury Bill rate plus a risk premium. The risk premium is obtained as the product of the average annual excess rate of return on a value weighted index of NYSE stocks (where the average is taken over a long period of time) and an estimate of the utility's NYSE beta.

Underlying this procedure is the assumption that risk premiums are *strictly* proportional to NYSE betas. However, this assumption is inconsistent with the academic empirical literature on CAPM. This literature supports a (non-proportional) linear relationship between risk premiums and NYSE betas with a positive intercept. Other empirical studies suggest that, in addition to betas, risk premiums are influenced by dividend yields and systematic skewness. Evidence presented in this literature is consistent with the predictions of CAPM models that account for margin restrictions on the borrowing of investors, divergent borrowing and lending rates, the existence of risky assets (such as bonds, residential real estate, unincorporated businesses, and human capital) that are not included in the value weighted NYSE stock index, taxes and skewness preference.

The version of the CAPM that should be employed in estimating a public utility's cost of equity capital cannot be conclusively demonstrated by theoretical arguments. A positive theory of the valuation of risking assets should not be judged upon the realism of its assumptions but rather on the accuracy of its predictions. The relationship between risk premiums and betas that is used to estimate the cost of equity capital should therefore be estimated econometrically rather than specified *a priori*.

Section 2 compares the predictions of alternative versions of the CAPM. The assertion that risk premiums are proportional to NYSE betas is shown to result in a downward (upward) biased prediction of the cost of equity capital for a public utility having a NYSE beta that is less (greater) than unity, a dividend yield higher (lower) than the yield on the value weighted NYSE stock index, and/or a systematic skewness that exceeds (is less than) its beta.

Section 3 discusses problems that arise in implementing CAPM approaches and presents possible solutions. Section 4 describes econometric procedures for

* Stanford University, Columbia University, and Bell Laboratories and Columbia University, respectively.

estimating the relationship between risk premiums and NYSE betas. Section 5 presents estimates of CAPM parameters, and, Section 6, using two utilities as examples, illustrates how these estimates can be used to measure the cost of equity capital.

II. Alternative versions of the CAPM: Theory and Evidence

The versions of the CAPM discussed below all assume that investors are risk averse and have homogeneous beliefs. They also assume that a riskless asset exists, that all assets are marketable, and that there are no transactions costs or indivisibilities. The mean-variance versions assume that expected utility is completely defined over the first two moments of the rate of return on investors portfolios. The three moment CAPM assumes that investors have utility functions displaying non-increasing absolute risk aversion and that expected utility is defined over the first three moments of the rate of return on investors portfolios. The before-tax versions ignore taxes while the after-tax versions account for the differential taxation of dividends and capital gains. The constrained borrowing versions allow unlimited short selling of risky securities while the unconstrained borrowing versions allow unlimited short selling of the riskless security (i.e., unlimited borrowing).

The Traditional Version of the CAPM

The traditional version of the CAPM developed by Sharpe [1964] and Lintner [1965] predicts the following relationship between risk premiums and betas,

$$E(\tilde{r}_i) = E(\tilde{r}_m)\beta_i, \tag{1}$$

where:

$E(\tilde{r}_i)$ = the risk premium, or expected excess rate of return above the riskless rate of interest, on the i-th security,
$E(\tilde{r}_m)$ = the risk premium on the market portfolio of all assets, and
β_i = $\text{Cov}(\tilde{r}_i, \tilde{r}_m)/\text{Var}(\tilde{r}_m)$, the beta of the i-th security measured against the true market portfolio of all assets.

Before-Tax Constrained Borrowing Versions of the CAPM

Constrained borrowing versions of the CAPM have been developed by Lintner [1969], Vasicek [1971], Black [1972], Brennan [1972], and Fama [1976]. They predict the following relationship between risk premiums and betas,

$$E(\tilde{r}_i) = E(\tilde{r}_m)\beta_i + E(\tilde{r}_z)(1 - \beta_i), \tag{2}$$

$$\text{or} \quad E(\tilde{r}_i) = E(\tilde{r}_z) + \beta_i(E(\tilde{r}_m) - E(\tilde{r}_z)) \tag{2A}$$

where:

$E(\tilde{r}_z)$ = the risk premium on the minimum variance zero beta portfolio.

With diverse investor preferences and no borrowing (Vasicek [1972] and Black

[1972]), divergent borrowing and lending rates (Brennan [1972]), or margin restrictions (Fama [1976]), the risk premium on the zero beta portfolio is positive (i.e., $E(\tilde{r}_z) > 0$). The first term on the RHS of relation (2) is the risk premium on security i that is predicted by the traditional CAPM. The second term is the bias inherent in that prediction when investor borrowing is constrained. Because $E(\tilde{r}_z) > 0$, the traditional CAPM's prediction of the risk premium would be biased downward (upward) for a public utility having a beta less (greater) than unity.

After-Tax Versions of the CAPM

After-tax versions of the CAPM have been developed by Brennan [1973] under the assumption of unlimited borrowing and lending and by Litzenberger and Ramaswamy [1979] under constrained borrowing. They predict the following relationship between risk premiums, betas and dividend yields,

$$E(\tilde{r}_i) = E(\tilde{r}_m)\beta_i + E(\tilde{r}'_z)(1 - \beta_i) + E(\tilde{r}_h)(d_i - \beta_i d_m), \tag{3}$$

where:

$E(\tilde{r}'_z)$ = the risk premium on a portfolio having a zero beta and zero dividend yield,
$E(\tilde{r}_h)$ = the expected rate of return on a hedge portfolio having a zero beta and a dividend yield of unity,
d_i = the dividend yield on stock i, and
d_m = the dividend yield on the market portfolio.

The first term on the RHS of relation (3) is once again the prediction of the traditional CAPM. The sum of the second and third terms indicates the bias inherent in this prediction. With constrained borrowing, the sign of $E(\tilde{r}'_z)$ cannot be determined theoretically; however, econometric estimates indicate that $E(\tilde{r}'_z) > 0$. This result implies that the second term on the RHS of relation (3) is positive (negative) for public utilities having betas less (greater) than unity. With the taxation of corporate dividends and the preferential taxation of capital gains, $E(\tilde{r}_h) > 0$. Therefore, the third term on the RHS of relation (3) would be positive (negative) for a public utility having a beta less (greater) than unity and a dividend yield that is higher (lower) than the dividend yield on the market portfolio. Thus, the sum of the second and third terms is positive (negative) for public utilities having betas less (greater) than unity and higher (lower) than average dividend yields, indicating that the prediction of the traditional version of the CAPM would be downward (upward) biased.

The Three Moment Version of the CAPM

The three moment CAPM, developed by Rubinstein [1973] and Kraus and Litzenberger [1976], predicts the following relationship between risk premiums, betas, and gammas (systematic skewness),

$$E(\tilde{r}_i) = E(\tilde{r}_m)\beta_i + E(\tilde{r}_w)(\gamma_i - \beta_i), \tag{4}$$

where:

$$\gamma_i = \frac{E[(\tilde{r}_i - E(r_i))(\tilde{r}_m - E(r_m))^2]}{E[(\tilde{r}_m - E(\tilde{r}_m))^3]}, \text{ the systematic skewness of security } i$$

$E(\tilde{r}_w)$ = the expected risk premium on a security having a zero beta and a gamma of unity.

With non-increasing absolute risk aversion, $E(\tilde{r}_w) > 0$. The second term on the RHS of relation (4) is the bias inherent in the traditional version of the CAPM. For a public utility whose future profitability is constrained by the regulatory process, gamma may be less than beta and, the risk premium predicted by the traditional version of the CAPM may be downward biased.

Missing Asset Version of the CAPM

Many classes of assets such as human capital, residential real estate, unincorporated business, and bonds are not included in the value weighted index of NYSE stocks. This "missing assets" problem has been analyzed by Mayers [1972], Sharpe [1977] and Roll [1977]. If the traditional version of the CAPM were valid (i.e., if risk premiums were proportional to true betas) it can be shown that,[1]

$$E(\tilde{r}_i) = E(\tilde{r}_s)\beta_{i,s} + E(\tilde{r}_{zs})(1 - \beta_{i,s}) + u_i \tag{5}$$

where:

$$u_i = E(\tilde{r}_m)\beta_{e_i,zs} - E(\tilde{r}_{zs})\{\beta_{i,zs} - (1 - \beta_{i,s})\}$$

and:

$\beta_{i,s}$ = the beta of security i w.r.t. the NYSE index,
$E(\tilde{r}_{zs})$ = the risk premium on the minimum variance zero NYSE beta portfolio,

[1] To obtain relation (5) note that without loss of generality the return on any security i may be expressed as,

$$\tilde{r}_i - E(\tilde{r}_i) = \beta_{i,s}[\tilde{r}_s - E(r_s)] + \beta_{i,zs}[\tilde{r}_{zs} - E(\tilde{r}_{zs})] + \tilde{e}_i$$

where:

$$E(e_i) = \mathrm{Cov}(e_i, r_s) = \mathrm{Cov}(e_i, r_{zs}) = 0$$

Multiplying both sides by $\tilde{r}_m$, taking expectations and dividing by the variance of $\tilde{r}_m$ yields.

$$\beta_i = \beta_{i,s}\beta_s + \beta_{i,zs}\beta_{zs} + \beta_{e_i},$$

where z is used here to refer to the zero beta portfolio related to NYSE index.

Substituting the RHS of the above relation for β_i in relation (1) yields

$$E(\tilde{r}_i) = [E(\tilde{r}_m)\beta_s]\beta_{i,s} + [E(r_m)\beta_{zs}]\beta_{i,zs} + E(r_m)\beta_{e_i}$$

Using the traditional CAPM to evaluate the terms in [·]'s yields

$$E(\tilde{r}_i) = E(\tilde{r}_s)\beta_{i,s} + E(r_s)\beta_{i,zs} + E(\tilde{r}_m)\beta_{e_i}$$

which, when rearranged, is relation (5) in text.

$\beta_{e_i,zs}$ = the beta of the residual of security i measured using a two factor model where the factors are the value weighted NYSE index and the minimum variance zero NYSE beta portfolio.

The first term on the RHS of relation (5) is the predicted return on security i obtained by naively assuming that the NYSE portfolio is the true market portfolio. If the NYSE portfolio were on the efficient frontier then the third term, u_i, would be zero for all i and the second term would be the bias inherent in this naive application of the traditional model. Thus, even if the NYSE portfolio were efficient and risk premiums were proportional to true market betas, risk premiums would not in general be proportional to NYSE betas. For example, if the NYSE portfolio was efficient, but riskier than the true market portfolio, there would be an *ex-ante* linear relationship between risk premiums and NYSE betas with a positive intercept (i.e., $E(\tilde{r}_i) = E(\tilde{r}_{zs}) + \beta_{i,s}(E(\tilde{r}_s) - E(\tilde{r}_{zs})))$.

However, there is no reason to believe that the NYSE portfolio is on the efficient frontier. Here the error term on the RHS of relation (5) would no longer be identically zero for all securities. However, the value weighted average of the error term on the RHS of relation (5) is zero.[2] Thus, for a randomly selected NYSE stock (i) where its probability of selection is proportional to its weight in the NYSE index, the expectation of u_i would be zero. Thus, when the NYSE portfolio is not efficient, *ex-ante* risk premiums would be linear functions of NYSE betas plus an error term. If the minimum variance zero-NYSE beta portfolio had a positive beta with respect to the true market, then its risk premium would be positive (i.e., $E(\tilde{r}_{zs} > 0)$). This would imply the existence of a (non-proportional) linear relationship between risk premiums and NYSE betas (with a positive intercept) plus an error term.

Other Versions of the CAPM

Other versions of the CAPM have been developed. Merton [1971], Cox, Ingersoll and Ross [1978], Breeden and Litzenberger [1978] and Breeden [1980] have derived intertemporal CAPM's that account for shifts in the investment opportunity set. The Merton and the Cox, Ingersoll and Ross studies present multi-beta equilibrium models. The Breeden and Litzenberger, and the Breeden studies, respectively, indicate that the relevant measure of risk is covariance with the marginal utility of consumption and a beta measured relative to aggregate consumption.

While the CAPM theories previously discussed were developed in terms of a single good model, they have been implemented using nominal rates of return. Gonzalez-Gaverra [1973] developed a model that accounts for unanticipated inflation. It suggests that *nominal* risk premiums are linearly related to *real* betas rather than nominal betas.

[2] This follows because for the value weighted index of NYSE stocks $\beta_{es,zs} = \beta_{sz} = (1 - \beta_{ss}) = 0$ by construction.

Implications of Empirical Evidence

Empirical studies by Black, Jensen and Scholes [1972], Fama and MacBeth [1973] and Friend and Blume [1973] find that the relationship between average excess rates of return and NYSE betas is linear, with a positive intercept, rather than proportional. There are at least three possible explanations for these results:

1. Constraints on investor borrowing;
2. Misspecification caused by the exclusion of classes of assets such as bonds, residential real estate, unincorporated business, and human capital from the index; and/or,
3. Misspecification caused by exclusion of other independent variables such as systematic skewness and/or dividend yield from the model.

Each of these explanations yields predictions that are inconsistent with the proportional relationship between risk premiums and NYSE betas that has been asserted in several recent rate cases that use CAPM. To the extent that the NYSE index is a good surrogate for the true market index, the first explanation suggests that a linear relationship between NYSE betas and risk premiums should be estimated and used to calculate the cost of equity capital. The second explanation suggests that a broadly based index should be used to calculate betas. Unfortunately, rate of return data do not exist for some classes of assets and are difficult to obtain for other classes of assets. This suggests that an exact linear relationship between risk premiums and NYSE betas does not exist. However, the NYSE betas of common stocks may be highly correlated with the true unknown betas (measured relative to the true market index). This suggests that the empirical relationship between risk premiums and NYSE betas should be estimated empirically rather than asserted *a priori*.

The third explanation suggests that the effect of other independent variables on risk premiums should be estimated and used in calculating the cost of equity capital. Empirical studies by Rosenberg and Marathé [1979], Litzenberger and Ramaswamy, and Blume [1979] find that, in addition to beta, dividend yield has a significant positive association with average excess rates of return. This result is consistent with the after-tax version of the CAPM and suggests that the relationship between risk premiums, NYSE betas, and dividend yields should be estimated and used to calculate the cost of equity capital. However, Litzenberger and Ramaswamy also present preliminary evidence indicating that the relationship between risk premiums, NYSE betas and yields is non-linear. This result is inconsistent with the Brennan, and Litzenberger and Ramaswamy versions of after-tax CAPM and therefore the use of a linear relationship between risk premiums, betas and dividend yield to calculate the cost of equity capital should be viewed as an approximation to a more complex non-linear relationship.

An empirical study by Kraus and Litzenberger [1976] found that, in addition to beta, systematic skewness (gamma) has a significant negative association with average excess rates of return. However, estimates of gamma are not stable over time and therefore it is not possible to obtain accurate *ex-ante* estimates of the systematic skewness of individual securities. Betas and gammas have a strong positive association, and, therefore, the use of a linear relationship between risk premiums and betas may again be viewed as approximation to a more complex relationship.

III. Implementing the CAPM Approach

This section discusses econometric problems that are associated with implementing the CAPM approach and presents possible solutions.

Measuring Expectations

The alternative versions of the CAPM discussed above are positive theories of the relationship between *ex-ante* risk premiums and betas.

Ex-ante risk premiums are not, however, directly observable. To handle this problem it is assumed that investors have rational expectations, that the excess rate of return (realized rate of return less the riskless rate of interest) on any portfolio or security in a given month is an unbiased estimate of its risk premium, and that the excess rates of return on each portfolio are independently and identically distributed over time.

Computing Beta

Estimates of the unadjusted betas for each security are obtained from an OLS regression of its excess rate of return on the value weighted NYSE index over a 60 month period. An advantage of using monthly data is that it mitigates the effect of the nonsimultaneity of closing prices. Recently Scholes and Williams [1978] have suggested the use of lagged rates of return as an instrumental variable for the errors in variables problem. Unfortunately, the CRSP daily data file is not available over a sufficiently long time period to be useful in estimating the parameters of the relationship between risk premiums and NYSE betas. Beaver, Kettler and Scholes [1970] and Rosenberg and McKibben [1973] have shown that accounting measures of risk are useful in predicting future betas. However, the Compustat data file, which would be necessary to estimate betas using either of their procedures, does not cover the 1926 to 1947 period.

It has been observed by Blume [1971] that historical betas which are adjusted towards unity are better predictors of future betas (in a mean square forecast error sense) than are unadjusted betas. One explanation of this phenomenon is that the true underlying betas follow a mean reverting process where the mean is unity. Another is that the true underlying beta is constant, the historical beta is a sample estimate of the true underlying beta, and the prior of the beta is unity. These explanations are not mutually exclusive and Blume [1975] has presented preliminary empirical evidence that the true underlying betas display reversion towards the population mean of unity.

Regardless of the cause of the phenomenon, the existence of reversion towards unity suggests that "adjusted" betas, computed as convex combinations of the historical beta and unity, are better predictors than are unadjusted betas. A possible approach is to assume that the same weight ω, $(0 < \omega < 1)$, is applicable to all securities such that,

$$\beta_i(\text{predicted}) = \omega\beta_{i(\text{historical})} + (1 - \omega)1.$$

This is the procedure used by Blume [1971] and by Merrill Lynch and is called a global adjustment approach. This approach implies a linear relationship between future betas and historical betas and suggests that unadjusted betas may be used to predict risk premiums. For example, consider the following relationship between excess rates of returns and globally adjusted betas,

$$\tilde{r}_i = a + b[\omega\beta_{i(\text{historical})} + (1 - \omega)1] + \tilde{e}_i.$$

This relationship reduces to the following relationship between excess rates of return and historical betas,

$$\tilde{r}_i = a' + b'\beta_{i(\text{historical})} + \tilde{e}_i$$

where

$$a' = a + b(1 - \omega), \quad \text{and}$$

$$b' = b\omega.$$

Note that for predictive purposes, a' and b' may be estimated directly; knowledge of ω is not required. If the ω used were constant over time, then the cost of equity capital estimates obtained using CAPM parameters measured using this global procedure would be identical to those obtained using unadjusted betas. This global adjustment procedure has the advantage of not depending on the exact cause or combination of causes for the empirical tendency of beta estimates to revert towards unity.

Another approach to adjusting betas is to use an individual Bayesian-adjustment procedure. This approach recognizes that the variances of sample betas (obtained from an OLS time series regression of stock returns on the NYSE index) are not identical. This approach is, however, based on the assumption that the true underlying beta is stationary which is inconsistent with Blume's preliminary empirical evidence. Under this approach, the probability of selecting a given stock is assumed to be proportional to its weight in the value weighted portfolio. Therefore, the diffuse prior estimate of its beta is unity. The variance of this prior is computed as

$$\text{Var}(\beta_{i,\text{prior}}) = \sum_{i=1}^{N_t} [[V_i / \sum_{i=1}^{N_t} V_i](\beta_{i,\text{sample}} - 1.0)^2] \quad (6)$$

where V_i is the value of firm i. Thus, the variance of the prior is the cross-sectional variation in sample betas around the value weighted mean of unity. It differs from the Vasicek [1971] adjustment, which computes the prior variance as,

$$\text{Var}(\beta_{i,\text{prior}}) = \sum_{i=1}^{N} (\beta_{i,\text{sample}} - 1.0)^2 / N$$

thus giving equal weight to each security. With either the global adjustment or the individual adjustment, the posterior estimate of beta has variance given by