Liquidity, Volatility, and Equity Trading Costs Across Countries and Over Time

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Abstract

Actual investment performance reflects the underlying strategy of the portfolio manager and the execution costs incurred in realizing those objectives. Execution costs, especially in illiquid markets, can dramatically reduce the notional return to an investment strategy. This paper examines the interactions between cost, liquidity, and volatility, and analyzes their determinants using panel-data for 42 countries from September 1996 to December 1998. We document wide variation in trading costs across countries; emerging markets in particular have significantly higher trading costs even after correcting for factors affecting costs such as market capitalization and volatility. We analyze the inter-relationships between turnover, equity trading costs, and volatility, and investigate the impact of these variables on equity returns. In particular, we show that increased volatility, acting through costs, reduces a portfolio's expected return. However, higher volatility reduces turnover also, mitigating the actual impact of higher costs on returns. Further, turnover is inversely related to trading costs, providing a possible explanation for the increase in turnover in recent years. The results demonstrate that the composition of global efficient portfolios can change dramatically when cost and turnover are taken into account.

1. Introduction

Investment performance reflects two factors: (1) The underlying investment strategy of the portfolio manager, and (2) The execution costs incurred in realizing those objectives. Recent evidence shows that execution costs can be large, often enough to substantially reduce or even eliminate the notional or "paper" return to an investment strategy. This is especially true in an international context, where execution costs are generally greater than in the United States and liquidity is sometimes scarce. Indeed, most portfolio managers regularly monitor their equity transactions costs, and few believe that such costs are not important to their bottom line.

An analysis of the magnitude and determinants of execution costs is valuable for other reasons. Execution costs vary systematically with market liquidity and return volatility, factors that must be considered when assessing the viability of alternative global investment strategies.[1] Global mean-variance efficient portfolios (and the perceived gain from international diversification) are affected by the inclusion of execution costs into return computations. Differences in trading costs and liquidity across markets are often cited as important factors in the international competition for order flow, and might shed light on the relative merits of different market designs. Cost considerations in emerging markets are especially relevant from a public policy perspective. For example, in emerging markets, large orders often result in substantial price movements raising concerns that foreign capital flows ("hot money") might destabilize domestic markets.[2] Large costs in emerging markets may also induce corporations to cross-list their stock in more liquid, developed markets, thereby hindering domestic market development. Finally, innovations in technology often are driven by cost considerations.

Yet, except for a handful of studies, there have been no attempts to analyze differences in trading costs and their determinants on a *global* basis.[3] This reflects difficulties in obtaining a common metric for trading costs across markets and over time, and matching this metric with

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[1] Bekaert and Harvey (1995). The joint analysis of volatility, costs and liquidity is also of interest because the risk premium reflects compensation for transactions costs and illiquidity. See Brennan and Subrahmanyam (1996) and Luttmer (1999).

[2] Choe, Kho, and Stulz (1999) provide an analysis of this issue for Korea.

[3] The leading exception is Perold and Sirri (1993), using much older and less comprehensive data than now are available. The literature on U.S. markets includes Huang and Stoll (1996), Chan and Lakonishok (1997), and Keim and Madhavan (1997), among others.

relevant auxiliary data. This paper examines magnitude and determinants of execution costs and analyzes the interactions between cost, liquidity, and volatility using panel-data for a broad sample of 42 countries from September 1996 to December 1998.

Our analysis provides several new and interesting results. We document wide variation in one-way equity trading costs across countries. Transactions costs are economically significant when juxtaposed against realized returns. Interestingly, transaction costs in emerging markets are significantly higher than in developed markets, even after correcting for factors affecting costs such as market capitalization and volatility. This is important because it suggests that reducing the cost of capital may be an important motivation for firms in emerging markets to cross-list their shares or issue American Depository Receipts (ADRs) in US markets. Implicit costs, such as market impact, represent roughly one-third of total cost, indicating the importance of estimating and monitoring these costs.

The panel nature of our data allows us to analyze the determinants of execution costs, and the interaction of costs, liquidity, and return volatility, both across countries and over time. Using a triangular panel-data model we find strong relationships between the variables of interest and shed light on the degree to which liquidity and costs are predictable in practice. Our results suggest that the composition of global efficient portfolios can change dramatically when costs are taken into account. We analyze the inter-relationships between turnover, equity trading costs, and volatility, and investigate the impact of these variables on equity returns.[4]

The paper proceeds as follows. Section 2 provides an overview of the data and our procedures to measure transaction costs; Section 3 summarizes the empirical evidence concerning the magnitude of international equity trading costs; Section 4 turns to an analysis of the determinants of costs; Section 5 provides a discussion of how costs affect the construction of global efficient portfolios; Section 6 examines the inter-relationships between turnover, equity trading costs, and volatility, and investigates their impact on equity returns; and Section 7 concludes.

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[4] Turnover is often used as a proxy for liquidity and we use this variable for this purpose too.

2. Data Sources and Procedures

2.1. Data Sources

The primary source of data for this study is Elkins/McSherry Co., Inc, a firm that conducts cost studies for institutional traders and serves as a consultant to stock exchanges. Elkins/McSherry receives trade data on all global trades by institutional traders and computes measures of trading costs. In 1998, the institutional traders in the data represented 135 firms, of whom 105 are pension funds, 27 are investment managers, and 4 are brokers. These institutions accounted for 28 billion shares in 632,547 trades, using 700 global managers and 1,000 brokers.

The data we have consist of average trading costs as a percentage of trade value for *active* managers in a universe of 42 countries. The data are quarterly, from the last quarter of 1995 through the third quarter of 1998. Of particular interest, the cost data are broken down into three components: commissions, fees, and market impact costs. We discuss these components in more detail in the following section. There may be trade-offs between the various cost components (i.e., using full commission brokers to minimize price impact but incurring higher fees as a result). Consequently, it is important to measure total trading costs as is done here.

Stock market data are compiled from a variety of sources. Data on turnover (defined as total trading volume divided by average market capitalization) and market capitalization (in millions of U.S. dollars) for emerging markets are obtained from the International Finance Corporation (IFC) Emerging Market Fact Book 1998. For non-emerging markets, data are gathered from Bloomberg Financial Services.[5]

2.2. Measurement Issues

It is common to decompose trading costs into two major components: *explicit costs* and *implicit costs*. Explicit costs are the direct costs of trading, such as broker commission costs, taxes, etc. While these costs are relatively small in the U.S. and have been declining, they can be large in other countries. Complicating matters, some countries (e.g., the United Kingdom) levy charges on only one side of the transaction, necessitating a breakdown between buys and sells for some mar-

[5] Countries are grouped into economic regions defined as follows: (1) North America (Canada and US), (2) West Europe (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Spain, Sweden Switzerland and UK, (3) Latin America (Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela), (4) Asia (Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore Taiwan and

kets. Our data breaks down the one-way transaction costs for buys and sells for two such markets, the U.K. and Japan. While the data distinguish between commission charges and other fees, changes in definitions over the sample period render these distinctions suspect. Accordingly, in our analyses we aggregate commission and fee cost into a single category of explicit costs.

Implicit costs represent indirect trading costs, the major one being the price impact of the trade. Unlike explicit costs where there are typically visible accounting charges, there is no such reporting of implicit costs. As a result, there is considerable disagreement over how best to measure implicit trading costs. Bid-ask spread estimates fail to capture the fact that large trades, that exceed the number of shares the market maker is willing to trade at the quoted bid and ask prices, may move prices in the direction of the trade. The resulting "market" or "price impact" of the transaction is the deviation of the transaction price from the "unperturbed price" that would have prevailed had the trade not occurred. This definition also captures one-half of the bid-ask spread.

The unperturbed price is usually defined as a weighted average of the prices surrounding the trade. An example is the popular volume-weighted average of price (VWAP) on the trade day. The approach used by Elkins/McSherry is closest to this approach. Every day, the company computes a benchmark price for every stock in the 42-country universe by taking the mean of the day's open, close, high and low prices. The price impact for a buy order is measured by the percentage difference between the execution price and this benchmark, and the reverse is true for a sell order. Willoughby (1998) reports that the price impacts computed using the Elkins/McSherry methodology are virtually identical to those computed using the VWAP approach. The great advantage of the Elkins/McSherry data is not in their methodology, but rather that their approach to computing implicit costs is the same for all countries, providing a common standard of measurement.

3. Magnitude of Equity Trading Costs

3.1. Cross-Sectional Variation in Total Costs and Composition of Costs

We begin by examining the pattern of trading costs across countries averaged over the entire sample period. This cross-sectional perspective is useful in that it dramatically illustrates the wide range in trading costs over countries and regions.

Thailand), (5) East Europe (Czech Republic and Hungary), and (6) Emerging Markets (Latin America, East Europe and Asia (excluding Japan), Greece, Portugal, and South Africa).

Table 1 reports the mean one-way implicit, explicit, and total equity transaction costs (in basis points, as a percentage of trade value) for the 42 countries in our sample over the sample period from September 1996 to December 1998, broken down by economic region.[6] Also shown in the table are the mean quarterly returns (in basis points) in the period from 1990 to 1998. Several results are of particular interest.

There is enormous variation in one-way equity trading costs across countries, ranging from a high of 198 basis points in Korea to a low of 30 basis points in France. There is considerable consistency in cost rankings from year to year. As reported by Willoughby (1998), the Paris Bourse is consistently one of the lowest exchanges in cost while South Korea is consistently one of the most expensive markets.

A juxtaposition of costs and returns illustrates the importance of trading costs to portfolio trading. The equally-weighted portfolio of all countries has one-way trading costs of 71.3 basis points. If this portfolio turns over every six months, annual average costs of $2 \times 2 \times 71.3 = 285$ basis points are incurred. By contrast, the average annual portfolio return (pre-cost) is $4 \times 307 = 1228$ basis points. Trading costs constitute 23 percent of raw returns in this scenario.

There also is variation in the *composition* of cost across countries, but both implicit and explicit costs are economically substantial in all cases. Overall, explicit costs are roughly two-thirds of total cost. This result is remarkably robust across regions, except for North America. The ratio is 62 percent for Latin America, 69 percent for Western Europe, and 62 percent for emerging markets, on average. There are also some emerging markets (e.g., Brazil) with very low implicit costs. This might reflect the investor base, which consists of large institutional traders who tend to concentrate their holdings in emerging markets in blue chip stocks where implicit costs are low. By contrast, previous studies show that in the U.S. implicit costs are much more significant as a fraction of costs, accounting for over 60 percent of the total. In the U.S., explicit costs are 0.2 percent of value and have been declining. This decline may reflect increased institutional presence in the market, resulting in a more competitive environment for trading services (institutions commonly negotiate lower commission rates), technological innovations in trading such as the increased use of low-cost Electronic Crossing Networks (ECNs) by institutional traders, and soft

[6] Our data contains information on NYSE and Nasdaq-NMS markets, but for reporting purposes we simply report a country average for the US and other countries with multiple markets.

dollar payments, by which brokers return a portion of the stated commission to institutional investors.

The correlation in explicit and implicit costs reinforces the importance of considering both costs together in investment analysis and trading decisions. The sample correlation between explicit costs and implicit costs is positive, ranging from 0.09-0.31 by year across the sample period, with no discernible trend. This indicates that the two execution costs are not substitutes for each other. Rather, markets with high market impact costs generally are also expensive in terms of explicit charges such as commissions. There are two notable exceptions, in which the correlations are negative within a region, namely East Asia and North America. In North America, for example, commissions and fees have been steadily declining, while market impact costs over the period remain relatively stable, declining only towards the end of 1998.

Finally, transaction costs in emerging markets are significantly higher than in more developed markets. Total costs are 95 percent larger relative to all other markets in the sample, and over double those observed in the U.S. Much of this difference lies in implicit trading costs, where emerging market costs are over 1.5 times those of more developed markets, but explicit costs also are a factor, being 70 percent higher in the emerging markets. We defer a more detailed discussion of this result until we formally analyze the determinants of trading costs and assess whether factors such as market capitalization and volatility can explain the higher cost figures for emerging markets. However, irrespective of the source of these costs, it is worth noting that the large trading cost differential between developed and emerging markets limits the gains from international diversification in these areas. We return to this issue in Section 5.

Although Table 1 reports only the sample mean for the US, our data allow a computation of execution costs across the two major US markets, the NYSE and Nasdaq. The NYSE operates as a specialist-auction market, where immediacy is provided by public limit orders and an exchange-designated specialist. Nasdaq is a dealer market, where multiple market makers post quotes prior to trading. The extent to which these differences in market structure affect execution costs is an important question.[7] There is evidence to suggest that quoted and effective spreads on Nasdaq stocks

[7] Similarly, there are differences between mean buy and sell costs in some countries (e.g., UK) because of factors such as stamp duties that apply only to, say, sales.

are generally wider than *comparable* exchange-listed stocks.[8] Using data for 10 quarters, we find that Nasdaq is consistently more expensive than the NYSE, consistent with earlier studies. Over the entire period, the New York Stock Exchange offered the second lowest among all countries; an average of 31 basis points, below the 45 basis points in Nasdaq-NMS stocks.

3.2. Time-Series Variation in Costs Across Regions

Longitudinal data allow us to examine the variation in trading costs over time. We are especially interested in whether there are any discernible trends in the pattern of equity trading costs. The sample period covers several events of economic interest. These include European economic integration, financial crises in Latin America, Asia, and East Europe, and intense competition for order flow among securities markets in developed countries arising from technological and regulatory change. Table 2 provides a time-series of average total (one-way) equity trading costs based on quarterly data for the period September 1996–September 1998. Cost estimates are in basis points, and are shown only for regions.

Transactions costs exhibit sharp declines over the period, with the exception of Eastern Europe, ranging from 10 percent in Latin America to 53 percent in North America. Values for the other regions are close to the average decline of 16 percent averaged over all countries. Falling costs are consistent with figures reported by Willoughby (1998). This may appear surprising given the financial market turmoil, but the decline is not uniform over the period. In particular, the percentage drop in costs calculated from the end of 1997 through the third quarter of 1998 is very close to the figures for the whole period. Most regions experience a small increase in costs in the last three quarters of 1997, with Latin America beginning earlier, in the first quarter. In other words, financial market turmoil is represented by higher trading costs in many regions, but the effect is generally small, about a 3 percent increase in Asia, for example.

The composition of trading costs also changes over the period. Overall, implicit costs fall three times faster than explicit costs. This relative decline in costs is observed for Western Europe, Asia, and emerging markets as a group, with declines in explicit costs from 9 to 10 percent, and a fall in implicit costs of 29 to 33 percent. The change in composition of costs in Latin America is the most pronounced, since explicit costs remained stable, while implicit costs fall by 23 percent.

[8] See, for example, Lee (1993), Huang and Stoll (1996), Chan and Lakonishok (1997), and Keim and Madhavan (1997).

The results reflect technological developments in these markets, including the introduction of sophisticated trading systems, the retrofitting of exchanges (often to automated execution technology), and advances in information dissemination. The composition of costs in North America is basically unchanged over the period. Implicit costs also fall by 51 percent as trading technology advances, and the decline in explicit costs due to brokerage and exchange competition is only slightly higher, at 54 percent.

Although not shown in Table 2, the NYSE and Nasdaq both exhibit declining trading costs. This decline is especially evident in Nasdaq stocks, possibly as a result of increased concern over bid-ask spreads following allegations of implicit collusion by Nasadaq dealers.[9] It also coincides with the reduction in the minimum tick size from one eighth ($0.125) to one-sixteenth ($0.0625) which is thought to have reduced spreads.

4. Determinants of Trading Costs

4.1. Interactions Among Trading Costs and Economic Variables

The wide range in costs documented above naturally leads us to an investigation of the *determinants* of execution costs. As a simple way of summarizing the interactions among the key variables of interest, we compute the Pearson correlation coefficients for total (one-way) trading costs, explicit costs, implicit costs, turnover, (log) market capitalization, return volatility, a dummy variable for emerging markets, and a dummy variable for markets using automated limit order book trading systems. We first compute sample means for the variables for 42 countries using quarterly data from September 1996 to December 1998 and then estimate correlations across countries. We perform tests of statistical significance at the 5 percent level under the null hypothesis that the correlation coefficient is equal to zero.

Table 3 contains the estimated correlation matrix. Several results are immediate. As expected, implicit costs are inversely related to market capitalization and positively related to volatility; they are also higher in emerging markets. Explicit costs primarily reflect exogenous regulatory factors and show little correlation with the other economic variables. The exception is the emerging market dummy variable, which is not surprising, given that such costs in emerging

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[9] See also Christie and Schultz (1994), Christie, Harris, and Schultz (1994), and Barclay, Christie, Harris, Kandel, and Schultz (1999).

markets are almost double those in more developed economies. This might arise because competition among brokers is weak in less developed markets, or because such markets simply face more regulation and are less efficient. Volatility is negatively related to market capitalization and is higher in emerging markets. Turnover is not significantly related to the other variables.

It is natural to use the estimates of trading costs to make inferences about the relative efficiency of alternative trading systems.[10] The countries represented in our sample offer a considerable range of different systems including pure dealer markets (London, Nasdaq), hybrid specialist-auction models (NYSE, Frankfurt, Amsterdam), matching systems (Japan), and automated limit order books (Paris, Toronto), the latter being the most common.[11] Accordingly, we include a dummy variable for markets with an automated limit order book system. As shown in Table 3, the dummy is significantly positively correlated with our emerging markets dummy and negatively related to market capitalization. The two findings are related. Automated systems are cheaper to build and operate than the dealer and floor based systems prevalent on more established markets, and a large percentage of such systems operating today are in emerging markets as a consequence. The ratio of average market capitalization in developed to emerging markets is over 150 at the end of our sample, which, together with the concentration of automation in the emerging sector, partially accounts for the negative correlation with market capitalization. Automated markets also are prevalent in much of Europe. The same connection with market capitalization applies there as well, with capitalization in North America being roughly 12 times that of Western Europe at the end of the period.

Automated systems, by virtue of reduced operating costs, and the possibility of eliminating the need for dealer or specialist intervention, might reduce trading costs, as suggested by Domowitz and Steil (1999) for the U.S. The correlations with cost here are positive, but not statistically significantly different from zero. Again, this appears to be a phenomenon related to the concentration of systems in emerging markets, which exhibit higher costs on average. Examination of the cost rankings in Table 1 reveals that automated systems in more developed venues tend to reduce implicit costs, in particular. Implicit costs for automated markets operating in New Zealand, Austra-

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[10] See, e.g., Reinganum (1990), Kothare and Laux (1995), Bessembinder and Kaufman (1996), and Huang and Stoll (1996), among others.

[11] See Domowitz (1993) for a list of systems and Domowitz and Steil (1999) for an update with respect to conversions of traditional markets to automated systems.

lia, Spain, Sweden, France, and Italy, for example, are between 5 and 14 basis points, compared with the overall average of 25 basis points and the figure of 30 basis points for the U.S.

4.2. A Statistical Model of Volatility, Cost, and Turnover

To better understand the factors affecting trading costs across countries we estimate models of the form

$$\mathbf{A}y_{it} = \mathbf{B}x_{it} + \lambda_i + \varepsilon_{it} \tag{1}$$

where $y_{it} = (\tau_{it}, c_{it}, \sigma_{it})'$. Here, c_{it} is total costs for each country i at time t, τ_{it} is turnover, and σ_{it} is volatility, measured as the absolute value of demeaned stock market index returns. The vector $\boldsymbol{x}_{it}$ consists of K pre-determined variables, described below. The vector error term, $\eta_{it} = \lambda_i + \varepsilon_{it}$, is assumed to consist of a random country-specific component, as well as an idiosyncratic term that varies both cross-sectionally and over time. **A** and **B** are 3×3 and 3×K coefficient matrices, respectively.

We impose the following restrictions on the **A** matrix,

$$\mathbf{A} = \begin{bmatrix} 1 & -\alpha_{12} & -\alpha_{13} \\ 0 & 1 & -\alpha_{21} \\ 0 & 0 & 1 \end{bmatrix}. \tag{2}$$

The recursive structure implicit in this formulation is economically logical. Volatility is an exogenous driver, a function of market, regional, and country-specific factors. In turn, volatility affects execution costs. Turnover is related to the cost of trading, and may be affected by volatility as well. While economic theory suggests higher costs will reduce turnover, the effect of volatility is ambiguous. Higher volatility may induce more trading because it is associated with a greater dispersion in beliefs. Alternatively, risk averse traders may reduce their trading in volatile markets.

The resulting triangular system is a natural approach to jointly estimating the interactions among the variables of interest while fully utilizing the panel nature of the data, and is consistent with the correlation analysis of the last section. It serves to identify the system, both for the purpose of estimation and for the computation of turnover response functions to follow, in the absence of a large number of exogenous observables available to us.

We did, however, statistically check for possible effects of turnover on cost and volatility, as well as for the potential of a direct impact of cost on volatility. We find no such significant relationships in the data set. For example, although a case might be made that lower trading costs induce market efficiency, reducing volatility, the evidence does not support such a hypothesis. We also cannot support the proposition that high turnover, representing the possibility of excess trading activity, destabilizes markets, as judged by the effect of turnover on volatility.[12] Finally, although trading costs might be considered lower for more active stocks, given evidence from U.S. cross-sectional analysis, such an effect is not independent of market capitalization. As will be seen below, market capitalization has an important impact on costs, and the preliminary analysis shows no additional statistical explanatory power for turnover with respect to cost as a dependent variable.

The cost measures used are total one-way trading costs. Given the trade-offs between implicit and explicit costs, and the changing composition of costs over time, we focus on total costs in our reporting.[13] Log transformations of all dependent variables are used. The explanatory variables are log market capitalization, and dummy variables for emerging markets and regions including North America, Asia, Latin America, and West Europe. Consistent with previous research from the U.S., we conjecture that trading costs are lower in more developed markets, and are lower in more liquid markets. The emerging markets variable captures residual costs idiosyncratic to the stage of market development.[14]

The financial crises of 1997-1998 primarily affected emerging markets, and for this reason we want to allow for different coefficient estimates for countries that are especially sensitive to foreign capital flows. To accomplish this in a parsimonious manner, we allow the coefficient α_{ij} to vary for emerging and developed capital markets. Specifically, we posit a relation of the form

$$\alpha_{i,j} = a_{i,j}^{D} + a_{i,j}^{E} D^{EMG}, \tag{3}$$

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[12] See also Coppejans and Domowitz (2000) for further discussion and references with respect to this point.

[13] Estimated models for implicit costs look very much like those for total costs, while explicit cost regressions add nothing beyond the summary statistics already presented, largely picking up regional effects.

[14] The analysis of the previous section suggests the use of a latent variable for automated markets. Given the concentration of such markets in emerging economies and in particular regions, the addition of such a variable results in

where D^{EMG} is a dummy variable taking the value 1 if the country is an emerging market. Similarly, we allow the coefficient on market capitalization to vary with respect to economic development in all regressions.

4.3 Cross-Sectional Influences on Trading Costs

Exogenous factors such as the financial crises and the concomitant time series variation in the data may obscure some fundamental influences on cost across countries. We therefore begin by examining a series of cross-sectional regressions. The triangular system is estimated for the second quarter of 1996, 1997, and 1998. Results for the cost equation are reported in Table 4. There are relatively few observations, resulting in larger standard errors, but the equations' adjusted R^2 ranges from 0.55 to 0.63, indicating a good overall fit to the data.[15] Several results stand out.

Cost increases with volatility in all cross-sections, although this effect generally is muted for emerging markets. Higher costs are associated with emerging trading venues, consistent with the evidence in Table 3. The impact is particularly large in 1998, reflecting the decline in costs in North America and Europe relative to emerging markets, documented in Table 2 and further illustrated by the negative regional effects in the 1998 cross-section. Higher market capitalization appears to reduces costs in emerging markets to a larger extent than in more developed trading areas, but relative to higher average costs. Regional variation plays a secondary role to the emerging market dummy, suggesting that market development rather than geography is the primary factor affecting cost.

4.4 Results from the Panel Data Model

The panel data model is estimated by generalized least squares for unbalanced panel data with individual effects (Searle (1971)). Coefficients and standard errors for the complete triangular system are reported in Table 5.[16] The effects captured by the turnover model, in particular, are substantive and statistically significantly different from zero, unlike the qualitatively similar

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severe multicollinearity, and is omitted. Latent variables indexing regional variation are important to the portfolio analysis to follow in section 5.

15 Even those studies using the most detailed data on trading currently available still do poorly in terms of predicting costs. For example, Keim and Madhavan (1997) regress estimated costs on proxies for trade difficulty, market-specific factors, and dummy variables for trader identity and style, and report that the regression R^2 ranges from 0.10 to 0.15. In other words, more than 85 percent of the variation in U.S. trading costs is idiosyncratic.

correlations presented previously. Additional structure from the model and estimation procedure, and the ability to parse out country and development effects, combine to produce sharper estimates of the correlations of interest.

Results from the turnover model show that lower costs of trading, usually associated with better liquidity, substantially increase activity. Should costs fall in other developed markets to the extent that they decline in North America over the sample period, turnover is predicted to increase by about 33 percent.

Turnover is less sensitive to cost in emerging markets than in more developed economies. The turnover cost elasticity is less than a fifth of that in non-emerging markets. Further, the emerging market dummy sharply reduces predicted turnover at the mean of the data. This is economically intuitive, because volumes in emerging markets might be driven more by politically exogenous factors such as privatizations, and are less sensitive to costs.

For emerging markets, higher capitalization increases turnover. This reflects a slight decline in emerging market turnover starting in the third quarter of 1997 accompanied by a fall in capitalization of roughly 40 percent over the following period. Cross-sectionally, there is simply more activity in larger capitalization issues in emerging markets. Turnover is lower in more highly capitalized developed markets.

Finally, although higher volatility appears to stimulate trading with shorter holding periods, the effect is statistically and economically negligible. The regional dummies also add little beyond the emerging market dummy, suggesting that market development rather than geographic region is the primary factor affecting activity.

We turn now to the total cost regression. The model fits well with an adjusted R-square of 0.59. Use of time variation in the data through the panel estimation sheds some additional light on the determinants of cost, relative to the cross-sectional analysis. The estimation results combined with the sharp decline in market capitalization over the sample period suggest that capitalization has a negligible, albeit statistically significant, effect on trading costs in emerging markets. The emerging market elasticity is only a tenth of that in more developed trading venues, where it continues to have an economically and statistically significant effect.

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[16] Quarterly time dummies are included in the panel data regressions, but the coefficients are not reported separately in the table.

The model continues to predict higher costs for emerging market countries, but the effect is now reflected in the time series variation in market capitalization. The emerging market dummy variable is negative, measured with a large standard error. The interaction with market capitalization is significantly positive, however, indicating that costs are higher in higher capitalization emerging markets such as Malaysia and Korea. The net impact of these two terms is to produce higher costs for emerging market countries. The variation in the data leading to this result reflects the financial crisis which hit the larger emerging markets – those having the greatest reliance on foreign capital – the hardest.

Volatility continues to have a positive, but economically negligible, impact on cost. The effect for emerging markets is slightly negative, but measured with a large standard error. Towards the end of the sample period, volatility increased due to financial crises in East Asia and Latin America.[17] Volatility rose 131 percent in East Asia, for example, from the second quarter of 1997 to the second quarter of 1998.

Although not reported in the table, coefficients on time effects reflect the average decline in trading costs over the period. Several factors influencing the time series variation in cost are being captured, of which the following are illustrative. Competition between markets for international order flow is increasing (Foerster and Karolyi (1999)), which can reduce domestic market spreads (Domowitz, Glen, and Madhavan (1998)). The widespread adoption of automated limit order book systems is a factor in reducing costs. Domowitz and Steil (1999), for example, document a decrease in explicit costs for listed stocks, and in total costs for OTC shares, of 60 percent and 30 percent, respectively, from trading on automated systems in the U.S. relative to traditional trading systems.[18] Finally, there is increased competitive pressure from new trading systems and regulatory authorities to reduce costs.[19]

Finally, the volatility regression shows that emerging markets – and Asian markets in particular – experienced higher volatility. Since the financial crisis was concentrated in East Asia and Latin America, this is not surprising. Larger market capitalization in emerging markets

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[17] See Bekaert and Harvey (1997) for an examination of time-variation in volatility in emerging markets.

[18] See also Pagano and Röell (1990), Pirrong (1996), and Schack (1999) for evidence on reduction of spreads in automated limit order books, relative to dealer and floor trading venues.

[19] Domowitz and Steil (1999) discuss the competitive landscape of exchange services competition. An example of regulatory pressure, and its effects, is given by Barclay, Christie, Harris, Kandel, and Schultz (1999).

tends to damp volatility, as might be expected, but the results for developed and emerging economies alike are statistically and economically negligible.

5. Global Efficient Portfolios

5.1. Costs, Turnover, and the Value of Diversification

Our analysis suggests that execution costs vary systematically with factors that are relevant for investment strategy. The estimated mean-variance efficient frontier – and hence the perceived gain from international diversification – also will change if execution costs are factored into return computations. This change derives in part from reduced returns, but may also be due to changes in the correlation structure of returns, as costs shift non-uniformly across countries. The effect is compounded because turnover is higher in emerging markets. Consider a portfolio focused on large capitalization issues in developed markets with annual (two-way) turnover represented by purchases and sales of 100 percent, management fee of 0.25 percent, and trading costs of 0.4 percent of value. The total costs are 0.4 percent×100 percent + 0.25 percent = 0.65 percent of portfolio value. By contrast, consider an emerging market portfolio with annual (two-way) turnover of 160 percent, costs of 1.25 percent of value, and management fee of 1 percent. This portfolio has total costs of 1.25 percent×160 percent +1 percent = 3 percent of portfolio value. Thus, ignoring risk, the emerging market portfolio would have to provide additional return of 2.35 percent per year to compensate for additional costs.

We now construct portfolios differentiated by costs and time periods for a set of markets representative of international investors' concerns. The market areas are North America, France-Germany-U.K., the remainder of Western Europe, Asia, and Latin America.[20] The holding period is assumed to be four quarters, with 100 percent turnover. We also estimate portfolios based on a two quarter holding period. Returns and standard deviations are reported on a quarterly basis using monthly dollar return data (converted using prevailing exchange rates) in the period from 1990 to 1996, before the start of our sample period.

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[20] North America includes US and Canada, Asia includes Japan, Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand, FGUK includes France, Germany and UK, West Europe includes Austria, Belgium, Denmark, Finland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden and Switzerland, Latin America includes Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.

The time series of observations is relatively short, and we rely upon cross-sectional variation within regions to help identify the covariance matrix for the mean-variance calculations.[21] Estimation is based on moment conditions, defined as follows. Let r_{nt}^{m} denote the stock index return for country n in region m at time t, while $\bar{r}_{n}^{m}$ is the average return for that country. The conditions defining the variance-covariance structure are given by

$$E\left[(r_{it}^{s}-\bar{r}_{i}^{s})(r_{jt}^{k}-\bar{r}_{j}^{k})\right]=\rho_{sk} \tag{4}$$

for s, k = 1,…,6 regions, and for all countries i in s and j in k, where E is the expectations operator. The regional variances are obtained by setting $s = k$. The parameters ρ_{sk} are estimated by method-of-moments based on the longitudinal data within and across regions. The covariance matrix is re-estimated when the returns are adjusted for transactions costs.

Transactions costs have a substantial impact on returns, and a relatively small effect on the variance-covariance matrix of the portfolio. Results by region, and for the minimum-variance portfolio over the full sample are reported in Table 6. For the minimum variance portfolio, transactions costs with annual rebalancing lower returns by 76 basis points, with no reduction in the volatility of the portfolio. Returns net of costs also fall sharply in the tangency portfolio, for which volatility actually increases by 60 basis points once costs due to annual rebalancing are taken into account. Examination of individual regions illustrates the factors contributing to these results. North American returns decline from 9.35 to 8.65 percent, compared to a world without transactions costs, while the standard deviation of returns falls only by 1.6 percent. A very similar impact of transactions costs is observed for other regions.[22]

One way to gauge the impact of transaction costs is to see how the composition of a global efficient portfolio would change as a result of including costs. For simplicity, we focus on the tangency portfolio, adopting the viewpoint of a US investor who views the riskless asset as a US treasury bond. The results, shown in Table 7 for two turnover levels, are dramatic. Indeed, the figures suggest large shifts in the tangency portfolio toward lower cost regions.[23] The weight

[21] The results are fundamentally unchanged if Japan is separated from other East Asian countries to form a separate portfolio, but that necessitates computations for Japan based only on a short time series, and is therefore omitted.

[22] Given short sale restrictions in many emerging markets, in particular, we impose a short sale constraint in these calculations. This has an effect only with respect to Asia, despite the positive expected return. Given the large trading costs observed in that region, the results are more dramatic if the short sale constraint is removed.

[23] Again, a short sale constraint is imposed, and consequently we omit Asia from the table.

for the low cost European countries increases by 15 percent under semi-annual rebalancing, while that for North America, which includes the relatively high cost Nasdaq market, declines by 36 percent. The implication is that considerable care is needed in constructing global efficient frontiers, both respect to costs and turnover.

5.2. Impact of Financial Crises

The full sample results cover two very different time periods, before and after the financial crises of 1997. The poor performance of Asian and Latin American countries means that these areas receive little or no weight in the full sample portfolios, especially once transactions costs are introduced. Also, while returns covariance matrices are not substantially changed once transactions costs are introduced, they are very different over the two periods. Accordingly, we split the sample into the period through the second quarter of 1997 and the period from the third quarter of 1997 to the last quarter of 1998. Returns and covariances are re-estimated, with and without costs, using actual return data in the period and the minimum variance portfolios are re-computed.

Transactions costs generate a 23 percent fall in returns for the minimum variance portfolio in the earlier period. The decline is over 85 percent greater than that observed for the full sample, reflecting in part the larger role played by the Latin American and Asian markets, and their higher transactions costs, in the optimal portfolio construction. The standard deviation of the portfolio falls only by about 5 percent compared to the computations without costs. The decline is only slightly larger than that observed in the full sample.

Costs increase slightly in most regions during the latter part of 1997, but decline in 1998 relative to the period prior to the second quarter of 1997. Returns including trading costs are nevertheless negative over this period outside of Europe. Transactions costs now result in a decline of 0.72 percentage points in returns for the minimum variance portfolio, a 6 percent fall in performance relative to the no cost case. Unlike the first period, however, the standard deviation of the portfolio increases slightly. Thus, costs generate a degradation of returns with a small increase in risk over a period of relative financial turmoil.

6. Interactions Between Volatility, Liquidity and Expected Returns

6.1. Construction of Response Functions

We turn now to an investigation of how changes in volatility, market development and costs affect liquidity and expected returns. The triangular panel-data model of Section 4 suggests that these relations can be complex. For example, an exogenous increase in volatility affects liquidity through its direct effect on turnover but also indirectly through its impact on transactions costs. Higher volatility increases costs, which reduces turnover, but also leads to more trading, so that the overall impact on liquidity of a shift on volatility is unclear. We use the panel-data estimates for the period 1996-1998 to construct response functions for the variables of interest. With these response functions in hand we can then investigate the effects of exogenous shifts in the variables of interest on expected returns. We focus here on the expected returns net of costs of a value-weighted global portfolio.[24]

The response functions first translate hypothetical changes in market capitalization, volatility, and market development into changes in transactions costs and turnover. Using the notation of section 4.2, the baseline (no change) case for the first step is defined by

$$y_i^* = \mathbf{A}^{-1}\mathbf{B}\bar{x}_i \tag{5}$$

where the bar denotes the time series average of the exogenous variables for each country *i*.

The results of changes to exogenous and endogenous variables in the first step are represented generally by

$$\hat{y}_i = \mathbf{A}^{-1}\mathbf{B}\tilde{x}_i + \mathbf{A}^{-1}\tilde{\varepsilon}_i \tag{6}$$

where the tildes denote values of the variables and innovations as dictated by the experiment. For example, if market capitalization, an element of x, is hypothesized to increase by 10 percent for all countries, $\tilde{x}_i$ contains 110 percent of average market capitalization for all *i*, together with the latent variables indexing status of development and region, including all interaction terms defined by equation (3). In the case of such a shock to an exogenous variable, the innovations are set to their theoretical mean of zero. A shock to volatility, an endogenous variable, is initialized

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[24] The analysis is also replicated for an equally-weighted portfolio of all countries, the tangency portfolio and the global minimum variance portfolio, as discussed below.

by setting $\tilde{x}_i = \bar{x}_i$ and $\tilde{\varepsilon}_i = \left(0,0,\tilde{\varepsilon}_{3i}\right)$. The $\hat{y}_i$ obtained for each such experiment are used to construct the portfolio returns in the second step.[25]

The y^* are used in the second step to produce baseline portfolio returns net of cost as in the preceding section. For each "experiment," defined as a percentage change in, for example, volatility, quarterly returns net of costs then are produced, and used to construct the value-weighted portfolio returns assuming a given turnover. The baseline, therefore, differs slightly from the results reported previously, since forecasts of costs are used to construct the returns, as opposed to using the actual data by region. Different assumptions regarding turnover give rise to different definitions of net expected returns. In the simplest case turnover is a constant, and the impact of costs is simply to subtract a constant amount from expected returns. Another case of interest is where the portfolio's rebalancing is related to turnover in the constituent countries, as might be the case with an active global fund. Accordingly, we adopt two definitions of net returns corresponding to constant and variable turnover. Formally, the portfolio's expected returns net costs corresponding to constant and variable turnover are defined, respectively, as

$$r_C^* = \sum_i \omega_i (\bar{r}_i - c_i T_i) \tag{7}$$

$$r_V^* = \sum_i \omega_i (\bar{r}_i - c_i T_i(\tilde{x}_i)) \tag{8}$$

where, for country i, ω_i is the portfolio weight (the ratio of the country's total stock market capitalization to the total market capitalization of all 42 sample countries), $\bar{r}_i$ is the expected gross return, c_i is the round-trip total transactions cost, T_i denotes constant turnover, and $T_i(\tilde{x}_i)$ allows turnover to be a function of other variables as given by equation (1).

6.2. Estimates

Computations are based on the coefficient estimates for the full panel. Perturbations to market capitalization and volatility are calculated from -50 percent to +50 percent, reflecting variation over the sample period, in increments of 0.10. Since much of the substantive variation in turnover appears to be idiosyncratic, based on the R^2 of turnover regressions, responses are

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[25] The covariance matrix is held constant across experiments, corresponding to the baseline case. The changes across experiments in the covariance structure are negligible.

computed with and without the contribution of volatility and capitalization to changes in turnover from a base of 100 percent per quarter.

Figures 1–3 show the effect of exogenous shifts in market capitalization (a proxy for development), volatility, and costs on our liquidity measure, i.e., turnover. Figure 1 graphs annual turnover as a function of market capitalization. It is evident that turnover declines as market capitalization grows, relative to the base case, reflecting the higher turnover in emerging markets. Figure 2 shows annual turnover as a function of volatility. Higher volatility increases turnover, consistent with models where heterogeneity in investors' beliefs is the source of trading volume. Turnover is decreasing in cost, as shown in Figure 3, consistent with the idea that investors' desires to trade are price sensitive.

We turn now to a discussion of how changes in these variables affect expected returns. The direct effect of an increase in capitalization from the baseline to 150 percent of the data average is to increase net returns by about 6.5 percent, a figure that increases slightly once shifts in turnover are taken into account. In the cross-sectional triangular system, an increase in capitalization first drives volatility down. The combination of decreased volatility and higher capitalization unambiguously lowers cost, increasing net returns. Although cost decreases, the other changes dominate, leading to a decline in turnover, further increasing returns.[26]

The direct effect of an increase in volatility on cost is positive, resulting in a decline in net returns. Specifically, an increase of 50 percent in volatility occasions roughly a 5 percent drop in returns for the value-weighted portfolio. If turnover also changes in the fashion predicted by the model, volatility has no substantive effect on portfolio returns net of trading costs. As cost increases together with volatility, turnover declines, canceling out the cost effect. This is illustrated in Figure 4 for the value-weighted portfolio which plots the net of cost annual return against volatility.

As in the last section, we repeat these exercises for the period prior to the financial crises, using the second quarter 1997 cross-sectional estimates of the triangular system and data averages up through that quarter. The qualitative results for the minimum variance portfolio are the

[26] In interpreting net expected return, it is important to understand that the return in question is the realized annual return given a fixed pre-cost expected return. Clearly, if changes in costs are predictable, this base return would adjust to keep returns net of costs constant.

same as for the overall sample, but robustness is obviously an issue given the lack of observations. The portfolio returns exhibit far less sensitivity to changes in capitalization and volatility, however, during the earlier period. A 50 percent increase in capitalization, for example, results in only a fractional percentage increase in returns net of costs, compared to the much larger movement reported for the full sample. Thus, sensitivity of net returns to the fundamentals represented by our observable variables appears to have increased in recent history.

7. Conclusion

Understanding of the magnitude and determinants of execution costs across countries and over time is vital to many practical and academic questions. A partial list of these topics includes the prediction of trading costs under alternative trading strategies, determining the effect of execution costs on realized (or "live") portfolio performance, understanding the behavior of institutional equity traders, making intermarket cost comparisons, and assessing arguments about the nature and causes of market fragmentation. The increased availability of detailed data on institutional equity trades in recent years has allowed us to greatly expand our knowledge of equity trading costs. This paper examines the magnitude and determinants of equity trading costs across a sample of 42 countries using quarterly data from September 1996 to December 1998.

We document a wide range in trading costs across countries. Emerging markets in particular have significantly higher trading costs of almost 46 basis points even after correcting for factors affecting cost such as market capitalization and volatility. Interestingly, costs have generally declined, except in East Europe, despite the recent financial market turmoil. This is consistent with Stulz (1999) who argues that globalization reduces the cost of equity capital because both the expected return that investors require to invest in equity to compensate them for risk and agency costs fall. We also discuss the implications of equity trading costs for policy makers and investors. In particular, we show that differences in trading costs across nations can significantly reduce the benefits to international diversification, partly explaining the "home bias" of domestic investors.[27]

[27] An extensive literature on the home bias and capital market segmentation exists. See, e.g., Stulz (1981) and Bekaert (1995). Karolyi (1996), Stulz (1999), and Lins, Strickland, and Zenner (1999) discuss how international cross-listing might overcome domestic market segmentation in emerging markets, reducing execution costs and hence improving share values.

Institutional traders and portfolio managers are especially concerned with being able to predict costs in real time. In this respect, the unpredictability of costs is an important factor. If traders are averse to the high variance in costs, they may alter their trading strategies towards strategies that let them better predict and control costs. Examples include crossing systems (where the crossing price is pre-determined), automated limit order book systems, or guaranteed principal bids, where the trading costs are known prior to trading. The extent to which the unpredictability in execution costs has led to innovations in trading technology is still an open question. For this reason, cost prediction is also important from a public policy viewpoint.

To improve our ability to predict execution costs we need to understand why the previous estimates are so noisy. There are two factors that complicate the task of estimating and predicting trading costs. First, while some elements of trading costs (e.g., commissions and taxes) are highly predictable, others (such as opportunity and timing costs) are highly variable and depend heavily on prevailing market conditions. Opportunity costs are also a function of the trader's investment style. For example, an index trader, whose objective is to mimic a benchmark portfolio with minimum tracking error, may incur very low opportunity costs but high price impact and commission costs. By contrast, a value trader, who seeks to identify stocks whose fundamental value exceeds the current stock price, may face large opportunity costs but small commission and price impact costs. Second, there are many unobservable factors that may explain the large variation in execution costs. A partial list of such variables includes trader reputation, skill, investment objectives, and subtleties of the trading process (e.g., upstairs intermediation) that are not easily measured.

The estimated models show strong relationships between the variables of interest and shed light on the degree to which liquidity and costs are predictable in practice. Our results suggest that the composition of global efficient portfolios can change dramatically when cost and turnover are taken into account. We analyze the inter-relationships between liquidity, equity trading costs, and volatility, and investigate the impact of these variables on equity returns. In particular, we show that increased volatility, acting through costs, reduces a portfolio's return. However, higher volatility reduces turnover also, mitigating the impact of higher costs on returns.

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Table 1

One-Way Equity Trading Costs and Components Across Sample Countries

This table presents estimates of average one-way equity trading costs in basis points for active managers in 42 countries in the period September 1996-December 1998 based on quarterly data provided by Elkins/McSherry Co., Inc. Explicit costs include both commissions and fees; market impact costs are computed by comparing the trade price to a benchmark price on the day of the trade. Data for the US represents average costs across AMEX, Nasdaq, and NYSE markets. Also shown in the table is the quarterly return in basis points for the country (ignoring transactions costs) in the period 1990-1998.

	Total Costs	**Explicit Costs**	**Implicit Costs**	**Mean Return**
Argentina	76.9	47.3	29.6	725
Australia	54.7	49.5	5.2	245
Austria	43.8	30.8	13.0	28
Belgium	35.0	25.4	9.6	424
Brazil	58.0	36.7	21.4	551
Canada	52.4	25.3	27.1	94
Chile	84.3	45.7	38.6	423
Colombia	97.5	55.3	42.2	693
Czech Republic	143.7	78.7	64.9	-242
Denmark	40.7	28.1	12.6	189
Finland	43.4	27.9	15.5	552
France	29.5	22.8	6.7	294
Germany	37.7	24.3	13.4	333
Greece	65.5	58.2	7.3	559
Hong Kong	59.8	50.6	9.1	479
Hungary	143.4	74.8	68.7	473
India	71.6	14.0	57.7	267
Indonesia	100.9	85.2	15.7	6
Ireland	130.7	106.0	24.7	422
Italy	34.8	26.3	8.5	576

Table 1 (Continued)

	Total Costs	Explicit Costs	Implicit Costs	Mean Return
Japan	41.3	31.7	9.5	-115
Korea	197.5	63.1	134.4	77
Luxembourg	63.8	20.1	43.6	341
Malaysia	88.7	73.8	14.8	94
Mexico	61.7	34.4	27.3	383
Netherlands	42.2	23.0	19.3	429
New Zealand	47.2	34.0	13.3	202
Norway	44.6	30.3	14.3	61
Peru	95.8	60.6	35.2	301
Philippines	112.7	103.2	9.5	250
Portugal	62.7	43.8	18.9	254
Singapore	77.5	60.8	16.7	205
South Africa	81.6	37.4	44.2	195
Spain	41.9	32.5	9.5	343
Sweden	35.8	26.2	9.6	378
Switzerland	38.5	29.8	8.7	563
Taiwan	74.6	56.0	18.6	120
Thailand	89.1	69.6	19.4	67
Turkey	64.6	41.0	23.6	208
UK	54.5	39.3	15.2	296
US	38.1	8.3	29.8	374
Venezuela	134.1	99.4	34.7	757
Mean	71.3	46.0	25.3	307
Std. Dev.	36.8	24.3	23.3	220
Maximum	197.5	106.0	134.4	757
Minimum	29.5	8.3	5.2	-242

Table 2
One-Way Equity Trading Costs Over Time and by Region

The table presents mean estimates of total (one-way) equity trading costs based on quarterly data provided by Elkins/McSherry Co., Inc for the period September 1996–December 1998. Total costs consist of commissions and fees and market impact costs. Market impacts are computed by comparing the trade price to a benchmark price on the day of the trade. All cost estimates are in basis points.

Quarter	All Countries	North America	West Europe	Emerging Markets	Asia	East Europe	Latin America
96 III	74.9	68.2	52.0	99.7	99.1	129.0	82.2
96 IV	77.2	54.0	52.9	104.3	99.9	148.6	83.0
97 I	75.0	63.0	50.8	98.7	97.8	176.3	92.6
97 II	70.6	49.3	46.8	94.8	91.8	139.9	95.7
97 III	71.5	43.8	47.6	97.4	93.0	123.7	94.9
97 IV	73.1	51.1	50.3	98.1	94.5	130.2	89.4
98 I	67.8	45.9	44.3	92.1	90.2	133.2	79.8
98 II	64.5	35.0	44.4	86.1	86.1	157.1	75.0
98 III	62.6	32.3	43.2	83.0	81.6	147.6	74.6
Mean	70.8	49.2	48.0	94.9	92.7	142.8	85.2
Std. Dev.	5.0	11.8	3.6	6.8	6.1	16.6	29.1
Maximum	77.2	68.2	52.9	104.3	99.9	176.3	95.7
Minimum	62.6	32.3	43.2	83.0	81.6	123.7	74.6

Table 3
Correlation Matrix

The table presents Pearson correlation coefficients for total (one-way) trading costs, explicit costs, implicit costs, turnover, (log) market capitalization, return volatility and dummy variables for emerging markets and automated limit order book trading systems for 42 countries. We first compute sample means for the variables using quarterly from September 1996–December 1998 and then estimate correlations across countries. An asterisk (*) indicates significance at the 5 percent level in a two-tailed test under the null hypothesis that the correlation coefficient is equal to zero.

	Total Cost	Implicit Cost	Explicit Cost	Turnover	Mkt. Cap.	Volatility	Emg. Market	Automated
Total Cost	1	0.784*	0.762*	-0.110	-0.543*	0.347*	0.642*	0.018
Implicit Cost		1	0.196	-0.152	-0.538*	0.368*	0.520*	0.232
Explicit Cost			1	-0.024	-0.296	0.166	0.473*	0.045
Turnover				1	-0.054	0.026	-0.123	-0.044
Mkt. Cap.					1	-0.342*	-0.466*	-0.315*
Volatility						1	0.507*	0.010
Emg. Market							1	0.642*
Automated								1

Table 4
Cross-Sectional Cost Regressions From the Triangular System

The table presents estimates of cost equations from a triangular system cross-sectional model for 42 countries, for the second quarter of 1996, 1997, and 1998, using Elkins/McSherry data. The dependent variable is (log) total one-way trading cost. The independent variables are (log) market capitalization (measured in billions of U.S. dollars), dummy variables taking the value 1 for markets in emerging markets, Asia, Latin America, and West Europe. Standard errors are in parentheses. An asterisk (*) indicates significance at the 5 percent level.

	Year		
Independent Variables	**1996**	**1997**	**1998**
Volatility	0.031 (0.106)	0.027 (0.096)	0.081 (0.072)
Market Capitalization	-0.113 (0.072)	-0.122* (0.053)	-0.073 (0.056)
D^{EMG}	0.670 (1.177)	0.517 (0.949)	2.532 (1.040)
$D^{EMG} \times$ Volatility	-0.160 (0.131)	0.061 (0.115)	-0.072 (0.102)
$D^{EMG} \times$ Market Capitalization	0.017 (0.096)	-0.023 (0.080)	-0.188* (0.090)
D^{ASIA}	0.289 (0.171)	0.271 (0.163)	0.165 (0.170)
$D^{LAT\text{-}AM}$	-0.159 (0.182)	0.038 (0.177)	-0.191 (0.205)
D^{US}	0.366 (0.407)	0.242 (0.290)	-0.024 (0.306)
D^{EUR}	-0.178 (0.174)	-0.208 (0.182)	-0.093 (0.201)
Constant	5.383* (0.938)	5.390* (0.665)	4.642* (0.717)
Number of Observations	38	42	42
Adjusted R-squared	0.545	0.617	0.626

Table 5
Triangular System Panel-Data Model

The table presents estimates of a triangular random-effects GLS panel-data model for 42 countries from September 1996–December 1998 using Elkins/McSherry data. The dependent variables are (log) turnover, (log) total one-way trading cost, and (log) return volatility. The independent variables are (log) market capitalization (measured in billions of U.S. dollars), dummy variables taking the value 1 for markets in emerging markets, Asia, Latin America, and West Europe using the IFC's definitions. Quarterly time dummies are included in the regressions, but not reported in the table. Standard errors are in parentheses. An asterisk (*) indicates significance at the 5 percent level.

	Dependent Variable		
Independent Variables	**Turnover**	**Cost**	**Volatility**
Cost	-0.647* (0.065)		
Volatility	0.004 (0.023)	0.004 (0.010)	
Market Capitalization	-0.293* (0.065)	-0.083* (0.025)	0.062 (0.057)
D^{EMG}	-8.356* (1.402)	-0.382 (0.437)	1.427 (1.079)
$D^{EMG} \times$ Volatility	0.017 (0.029)	-0.019 (0.013)	
$D^{EMG} \times$ Cost	0.530* (0.211)		
$D^{EMG} \times$ Market Capitalization	0.571* (0.084)	0.075* (0.036)	-0.065 (0.099)
D^{ASIA}	0.075 (0.385)	0.196 (0.140)	0.510* (0.174)
D^{LAT-AM}	-0.870* (0.417)	-0.036 (0.151)	-0.031 (0.191)
D^{US}	0.877 (0.699)	0.079 (0.255)	0.014 (0.351)
D^{EUR}	0.528 (0.435)	-0.172 (0.155)	0.205 (0.186)
Constant	8.691* (1.194)	4.804* (0.339)	0.421 (0.738)
Number of Observations	372	394	394
R-squared (Between)	0.312	0.621	0.619
R-squared (Overall)	0.281	0.590	0.234

Table 6
Global Efficient Portfolios With and Without Transactions Costs

This table contains *annual* returns (in basis points) for North America, France-Germany-UK, Asia, Western Europe, and Latin America, and for the minimum variance and tangency portfolios constructed from those countries and regions. Mean returns for the regions are computed using equity returns to US investors from the period from 1990-1996. The US risk free rate is used in the construction of the tangency portfolio. Transactions costs are computed using Elkins/McSherry data, and the statistics "with transactions costs" are based on (1) annual rebalancing with 100 percent turnover per annum, and (b) semi-annual rebalancing with 100 percent turnover every six months. A short sales constraint is imposed.

	Return Without Transactions Costs	Return With Transactions Costs	
		Annual Rebalancing	Semi-annual Rebalancing
North America	935	865	795
Asia	525	353	181
France, Germany, UK	1233	1155	1077
West Europe	1370	1276	1181
Latin America	2237	2089	1942
Minimum Variance Portfolio	1073	997	921
Tangency Portfolio	1300	1230	1170

Table 7
Composition of the Global Efficient Tangency Portfolio With and Without Transactions Costs

This table contains the portfolio weights, in percent, for North America, France-Germany-UK, Western Europe, and Latin America in the global efficient tangency portfolio constructed from those countries and regions. Mean returns for the regions are computed using equity returns to US investors from the period from 1990-1996. The US risk free rate is used in the construction of the tangency portfolio. Transactions costs are computed using Elkins/McSherry data, and the statistics "with transactions costs" are based on (1) annual rebalancing with 100 percent turnover per annum, and (b) semi-annual rebalancing with 100 percent turnover every six months. A short sale constraint is imposed, so that Asia is excluded.

	Portfolio Weight Without Transactions Costs	Portfolio Weight With Transactions Costs	
		Annual Rebalancing	Semi-annual Rebalancing
North America	26.6	22.5	16.9
France, Germany, UK	31.8	33.8	36.5
West Europe	31.1	32.6	34.5
Latin America	10.5	11.1	12.1

Figure 1: Annualized Turnover for a Value-Weighted Portfolio of All Countries as a Function of Market Capitalization Based on Triangular Panel-Data Estimates for 1996-1998 function of Market Capitalization

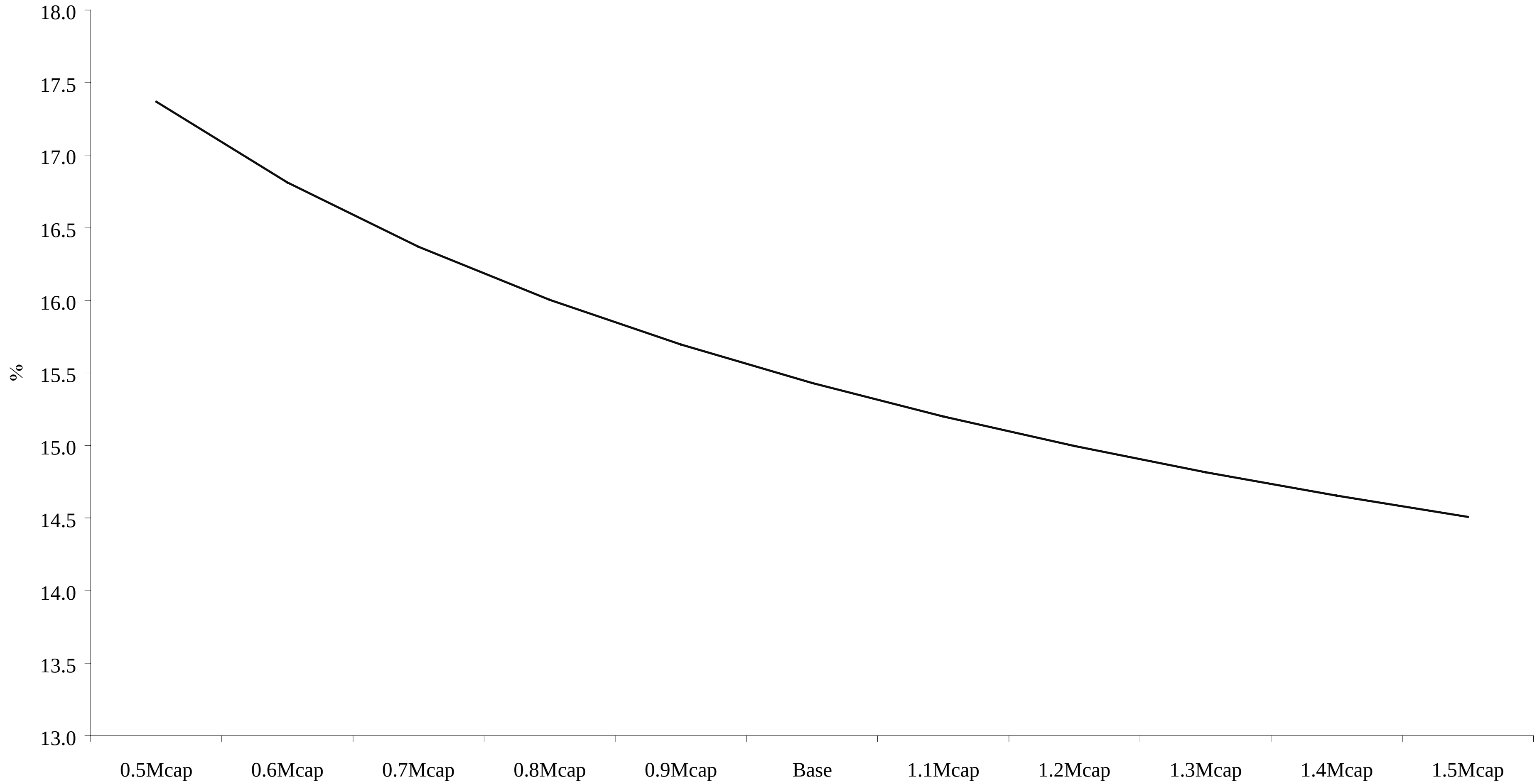


Figure 2: Annualized Turnover for a Value-Weighted Portfolio of All Countries as a Function of Volatility, Based on Triangular Panel-Data Estimates for 1996-1998

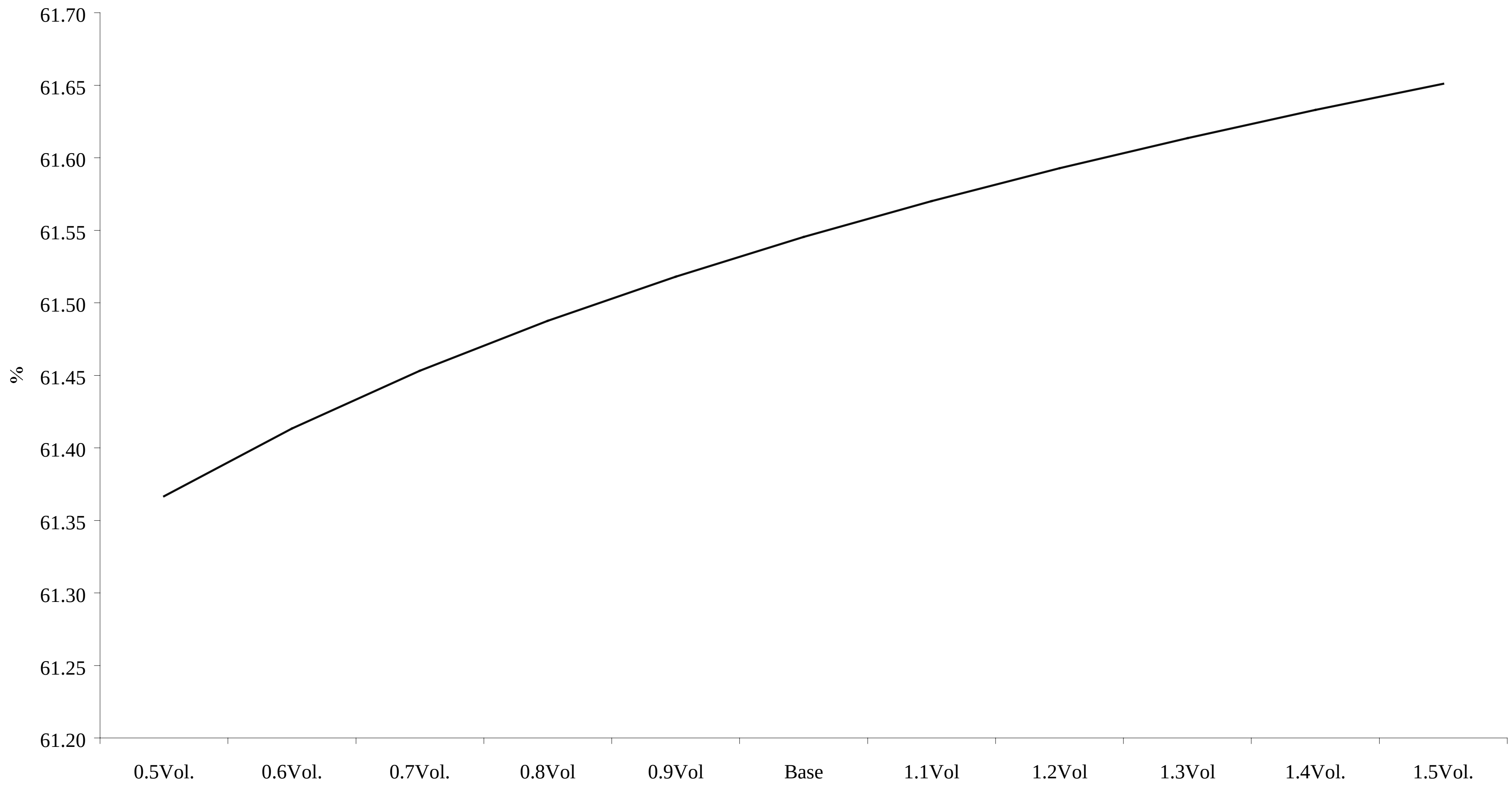


Figure 3: Annualized Turnover for a Value-Weighted Portfolio of All Countries as a Function of Total Costs Based on Triangular Panel-Data Estimates for 1996-1998

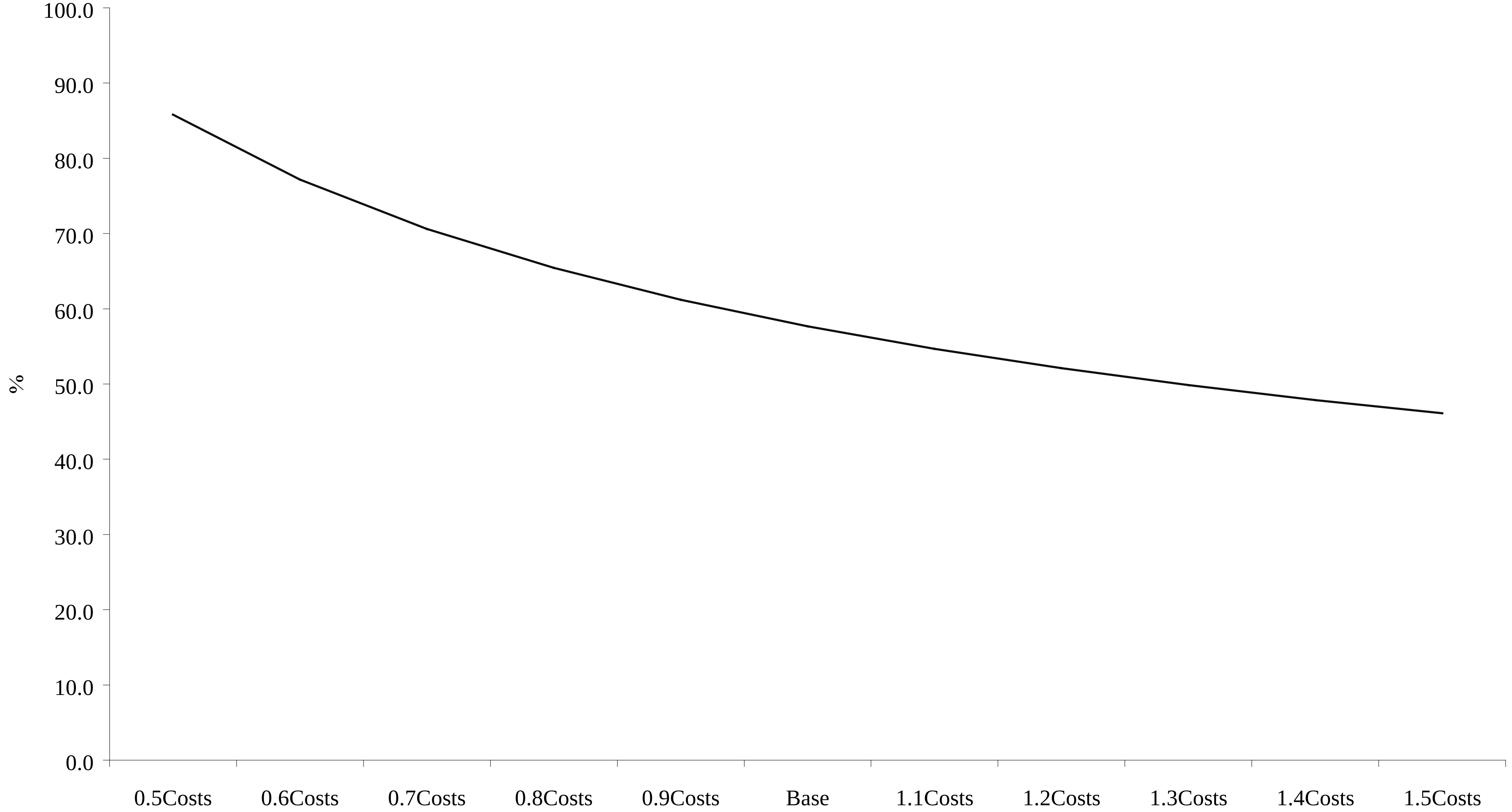
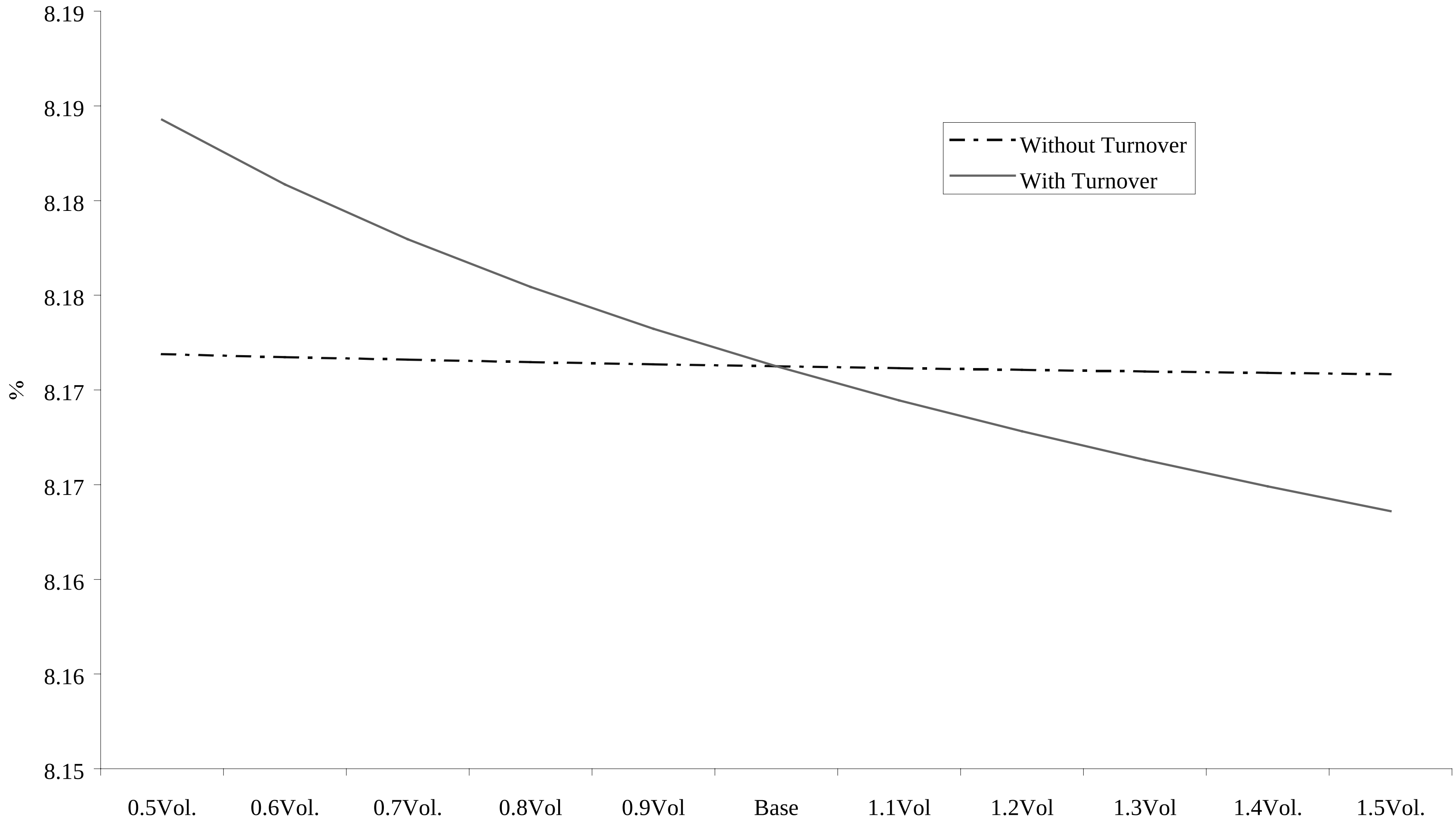


Figure 4: Annualized Net Returns for a Value-Weighted Portfolio of All Countries as a Function of Volatility With and Without a Turnover Equation, Based on Triangular Panel-Data Estimates for 1996-1998



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