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Memorandum No. 1725

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June, 2004

ISSN 0169-2690

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Market Impact Costs of Institutional Equity Trades

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7th May 2004

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Abstract

This paper is the first to analyze market impact and execution costs of equity trading by a pension fund. We find that, on average, these costs are nonnegligible. Average market impact costs equal 20 basis points for buys and 26 basis points for sells; average execution costs equal 27 basis points and 33 basis points, respectively. Furthermore, we show that relative trade size and market capitalization, commonly found to play an important role, have only limited influence on the market impact of a trade. The most important determinants of the price effect are momentum, stock price volatility, investment style, trade type (agency, single, or principal), and trading venue.

Keywords: market impact costs, trading costs, price effects, institutional equity trading, pension funds

AMS Subject Classification: 62P20, 62J05
JEL Classification: E32, G14, G23, G28

Introduction

Institutional investors today account for a large part of international stock holdings and equity trading. For example, in 2001 they owned more than 50% of total US equities[1]. Furthermore, Schwartz and Shapiro (1992) estimated that institutional investors and their member firms accounted for about 70% of total trading volume on the New York Stock Exchange (NYSE) in 1989. Since institutional investors occupy such a predominant position in the equity trading process, the literature has paid much attention to the impact of institutional trading on stock prices. For a survey, see Keim and Madhavan (1998). The upshot of their survey is that institutional trades cause nonnegligible price pressure.

The existence of substantial price effects has important consequences for institutional investors, since they may cause additional trading costs ('market impact costs'). Trading costs occur when price effects cause execution prices to be less favorable than the benchmark price. Usually the decision to buy or sell a particular asset is based on expectations about the future performance of this asset. Buying a stock with high expected returns might result in worse performance than expected if trading costs for this particular stock are high. In such a case a stock with lower expected returns may perform better if its trading costs are lower. Therefore, knowing the trading costs on each stock up front might change the optimal portfolio holdings of an institutional investor. This makes trading costs an important factor to consider when trading decisions have to be made, since ignoring them reduces the performance of the portfolio substantially. Moreover, for large institutional investors huge amounts of money are involved. Even a few basis points of savings may represent a large amount of money.

Trading costs are also of interest from the perspective of regulators such as the U.S. Securities and Exchange Commission. Financial markets must have proper rules to ensure efficient execution of market transactions. Regulators have coined the concept of 'best execution' as a way to provide an assessment of the reasonableness of the prices of market transactions; see Wagner and Edwards (1993) and Macey and O'Hara (1997). Although the distinction between intentional failure and poor performance is hard to make, poor performance can be assessed by means of statistical methods.

Moreover, the central bank, which is responsible for financial stability, is also interested in the price effects of institutional equity trading. Institutional trades are motivated by various reasons, such as investment strategies, risk management or regulatory rules, and may possibly affect equity prices. Price effects, in turn, affect the wealth of consumers, firms and pension funds, and may influence their behavior.

This paper analyzes the market impact of the equity trades of the largest Dutch pension fund and is, as far as we know, the first paper to investigate market impact and execution costs incurred by a pension fund. The 'Algemeen Burgerlijk Pensioenfonds' (ABP) has 2.4 million clients and an invested capital of about 156 billion Euro.[2] Its assets constitute about one third of total Dutch pension fund assets. Furthermore, ABP is not merely the largest pension fund of the Netherlands, it is also among the five largest pension funds in the world. A unique data set, containing detailed information on all worldwide equity trades of ten different funds at ABP during the first quarter of 2002, is used to identify the trade and stock-specific characteristics that determine the expected price impact of trading. Moreover, in order to gain more insight into fluctuations in the price impact, this paper extends the existing literature by assessing the determinants of the volatility of the price effects as well. Since the data provide a wide set of trade and stock-specific characteristics including investment style, they allow for detailed analysis of the determinants of the price impact of ABP trades.

We find that, on average, market impact and execution costs of the pension fund's trades are nonnegligible. Average market impact costs equal 20 basis points for buys and 26 basis points for sells; average execution costs (defined as the sum of commission and market impact) equal 27 basis points and 33 basis points, respectively. Furthermore, we show that relative trade size and market capitalization − variables that are often found to be significantly related to price effects in the existing literature − have some influence on the expected market impact and the volatility of the market impact costs. However, they are considerably less important than momentum, stock price volatility, investment style, trade type (agency, single, or principal), and trading venue. This is partly in line with Chan and Lakonishok (1993, 1995), who find that the importance of relative trade size and market capitalization pales beside the importance of investment style. The important role of the trading venue in explaining market impact coincides with the findings of Domowitz, Glen, and Madhavan (2002), who document wide variation in equity trading costs across countries.

This paper is organized as follows. Section I provides a brief review of the literature on the price effects of institutional trading. Section II describes the data set containing information on the equity trades of the pension fund. Some sample statistics on the temporary and persistent price effects of the ABP trades are presented in Section III. Section IV assesses the determinants of both the expected price impact and the volatility of the price effects. Finally, Section V summarizes and concludes.

I Price effects of institutional equity trades: a literature review

Quite a number of articles have been devoted to market the impact and execution costs of institutional equity trades.

Chan and Lakonishok (1993) examine the price impact of institutional trades on the basis of transaction data of 37 large institutional money management firms during a two and a half year period (1986−1988). Correcting for market-wide stock price movements, the authors find that the average price change weighted by the dollar size of the trade (called the principal-weighted average) from the open to the close on the trade day equals 34 basis points (bp) for buys and −4 bp for sells.

Using the same data as Chan and Lakonishok (1993), a similar analysis is presented in Chan and Lakonishok (1995). In the latter paper the authors do not measure the market impact of individual trades but of trade packages. The authors define a trade package as a series of successive sells or purchases of the same stock, which ends when the money manager stays out of the market for at least five days. After adjustment for market-wide price movements, the principal-weighted average price change from the open on the first trading day of the package to the close on the last day amounts almost 100 bp for buy packages and −35 bp for sell packages.

Keim and Madhavan (1997) investigate the total execution costs (defined as the sum of commission and market impact costs) of institutional trades in relation to investment styles, using data on the equity transactions of 21 institutions during the 1991−1993 period. They distinguish fundamental value managers (who focus on assessment of fundamental value, with a long-term perspective), technical managers (who focus on short-term price movements), and index managers (who focus on mimicking the returns of a certain index). The authors show that total execution costs are significant and that value traders have lower costs than traders using strategies that require more immediacy. Keim and Madhavan (1997) also explain execution costs from trade difficulty. Trade difficulty is measured by variables such as relative trade size, which has a positive impact, and market capitalization, which has a negative effect on the execution costs. Additionally, the authors relate the execution costs to the trading venue by showing that for institutional trades in Nasdaq stocks, costs tend to be higher than for trades in comparable exchange-listed stocks. The authors find that the magnitude of the average total execution costs varies between 49 bp and 123 bp for buys and between 55 bp and 143 bp for sells. On average, commission contributes about 40% to total execution costs.

Chan and Lakonishok (1997) also analyze the effect of the trading venue on execution costs. The authors compare the total execution costs on the NYSE and the Nasdaq for institutional investors, using transaction data from 33 large institutional money management firms during a two and a half year period (1989−1991). Median total execution costs on the Nasdaq are 99 bp versus 54 bp on the NYSE. Moreover, the authors show that − after controlling for firm size, relative trade size, and the money management firm's identity − the execution costs are lower on the Nasdaq for trades in smaller firms and lower on the NYSE for trades in larger firms.

Wagner and Edwards (1993) analyze a sample of institutional trades during the second quarter of 1992 and investigate price effects. They establish average market impact costs of 18 bp.

Domowitz, Glen, and Madhavan (2002) investigate execution costs across 42 countries in the period September 1996 until December 1998. The authors document wide variation in execution costs, even after correcting for factors affecting costs such as market capitalization and volatility. Average execution costs vary from 30 bp in France up to 138 bp in Korea.

Several studies analyze the market impact of trades using more general transactions data on block trades that are typically initiated by institutional investors, and often on the so-called upstairs market. On the upstairs market, large institutional block trades are processed through a search-brokerage mechanism. That is, an intermediary or broker first identifies counter parties to trade, after which the order is sent to the downstairs market for final execution. By contrast, smaller trade are routed directly to the downstairs market, where market makers, floor traders, and limit orders provide liquidity on demand.

By analyzing data on upstairs block trades traded at the NYSE, the NASDAQ, and the AMEX from July 1985 until December 1992, Keim and Madhavan (1996) show that the average price effect of NYSE-traded stocks belonging to the bottom half of market capitalization equals 145−451 bp for buys and 434−1,024 bp for sells.

Madhavan and Cheng (1997) examine data on block transactions in Dow Jones stocks executed on both the upstairs and downstairs NYSE market. They show that the upstairs market provides significantly better execution of transactions than the NYSE floor market, although economically speaking, the differences are small. The authors establish average market impact costs of 18 bp (upstairs) and 19 bp (downstairs) for buys. For sells they find average price effects between 15 bp (upstairs) and 16 bp (downstairs).

Using transaction data on upstairs and downstairs trades on the Toronto Stock Exchange in June 1997, Smith, Turnbull, and White (2001) show that the adverse selection costs of trades on the upstairs market are significantly lower than on the downstairs market. Furthermore, they show that the price impact of trades depends on the trade type (agency or principal). The authors establish an average implementation price effect of 22 bp (downstairs), 25 bp (upstairs), 27 bp (upstairs, agency), and 22 bp (upstairs, principal).

II Data and definitions

The data under consideration contain the worldwide trades of ten different funds at ABP during the first quarter of 2002. Each fund corresponds to one of the regions Europe, United States, Canada, and Japan. Each fund has its own benchmark being the MSCI Europe, the S&P 500, the Toronto Stock Exchange E300 (TSE E300), and the MSCI Japan, respectively. During the period covered by the data set three funds were managed quantitatively and seven fundamentally. These quantitative funds exploited monthly to quarterly mispricings of individual stocks based on quantitative models. The fundamental funds had a semi-annual or longer-term qualitative view on the fair value of a company or sector and their portfolios were constructed to reflect these views. This implies that the quantitative funds traded with much more urgency than the fundamental funds.

Virtually all available observations of buys and sells are related to the so-called rebalancing activities of the pension fund. Rebalancing – adjustment of the portfolio weights by selling and buying stock – takes place every month and only occasionally additional trades are executed. Price changes over time cause portfolio weights to deviate from the optimal ones, so that rebalancing becomes necessary.

The sample consists of 3,728 trades executed during the first three months of the year 2002 with a total transaction value of 5.7 billion Euro. Of these trades, 1,963 are buys and 1,765 are sells. The total market value of buys and sells is about the same: 2.9 billion Euro for buys and 2.8 billion Euro for sells. ABP invested about 50 billion Euro (equivalent to 35% of total invested capital) in equity in the first quarter of 2002. However, the portfolios analyzed in our sample had a value of 20 billion Euro. Hence, the trades analyzed in this paper constitute approximately 28% of this value.

Unfortunately, the database only provides the direction of the trade as seen from the perspective of the pension fund and does not tell whether a buy by the pension fund is also classified as a buy on the stock market. A buy by ABP is not necessarily a buy on the stock market, since the sign of a trade is determined by the direction of the order that removes volume from the order book. Moreover, since the data do not provide information on the prevailing bid and ask quotes either, we can not use the Lee and Ready (1991) rule to assess the trade sign. However, the primary goal of this paper is to assess the impact of a trade when the pension fund sells (or buys) a large amount of stocks. Therefore, it is natural to condition on the direction of the trade as seen from the perspective of the pension fund. Clearly, the true sign of the trade could have additional explanatory power, but we are able to do our analysis without this information.

For each transaction the data provide the execution price and a benchmark price in Euro. The benchmark price is the price of the stock just before the trade was passed to the broker. Moreover, the data also tell when the trade was submitted to the broker and when it was executed. The data also provide the amount of commission that was paid, which is used to compute the fee rate. Additionally, the data include detailed information on several trade and stock-specific characteristics including the investment style of the fund, which will be discussed below.[3]

The data set has been constructed on the basis of the post trade analysis, provided by ABP Investments. The remaining data were taken from Factset and Reuters.

Possible determinants of the price impact

With respect to trade-specific characteristics, the data set contains information on the country the stock was traded, trading volume, and the type of trade (agency, single, or principal). Country dummies on a regional level have been constructed to distinguish between Europe, United States, Canada, and Japan. Two relative measures of trading volume are considered: relative to total shares outstanding and relative to daily trading volume.[4] With respect to the type of trade, there are three possibilities. An agency trade is a trade between the pension fund and a counter party, where the broker acts solely as an intermediate party. Hence, an agency trade involves two clients of the brokerage firm, one of them being the pension fund. A principal trade is a transaction between the pension fund and the broker, in which case the broker buys or sells stocks from or to the pension fund at a predetermined price. Hence, a principal trade involves the brokerage firm and the pension fund. Single trades apply to difficult trades that are traded separately, not necessarily with packages of other stocks. It is up to the pension fund itself to decide an agency, principal, or single trade. The largest part of the data consists of agency trades (2,178 observations). The remaining trades are either principal (1,439 observations) or single (111 observations).

With respect to stock-specific characteristics we distinguish market capitalization, volatility, momentum, value and growth stocks, and sector dummies. Market capitalization is computed as the dollar value of the trades outstanding, using the amount of shares outstanding three months prior to the trade (to avoid the look-ahead bias). Volatility is computed over the last thirty trading days prior to the trade. The period of 30 days is chosen to ensure that recent price fluctuations are incorporated in the measure of volatility. Momentum is computed as the volume weighted average daily return on a stock over the last five trading days prior to the trade. Roughly speaking, momentum indicates whether there is a buying or a selling trend for a particular stock. A binary variable distinguishes between value and growth stocks on the basis of its membership of the MSCI Value and Growth Index.[5] Value stocks have a relatively low book-to-price ratio, while this ratio is relatively high for growth stocks. The sector dummies classify each stock into one of the following sectors: consumer discretionary, consumer staples, energy, financials, health, industry, information technology, materials, telecommunications, and utilities. These sectors correspond to the Global Industry Classification Standard, see Table I.

The data also contain information on the trading style of each of the funds under consideration. A dummy variable indicates whether a fund is quantitative or fundamental, where quantitative funds correspond to positive-feedback strategies focusing on short-term price movements and fundamental funds to negative-feedback strategies with a long-term horizon.

Sample properties of ABP trades

Table II reports sample statistics (such as means, standard deviations, medians, and quantiles) of several trade characteristics such as trade duration, various measures of (relative) trade size, and commission, for both buys and sells. Average trade size for buys (sells) is more than 70,000 (84,000) shares and the average value of a trade equals almost 1.5 (1.6) million Euro. Expressed as a percentage of daily trading volume and shares outstanding, average trade size of buys equals 4.29% and 0.02%, respectively. For sells these percentages are 3.41% and 0.02%. Moreover, on average, it takes almost 4 (4.5) hours before a buy (sell) transaction has been executed.

Table III provides information on the nature of the stocks that have been traded by the pension fund. The second part of Table IV provides a description of the abbreviations of the variable names used in Table III. For both buys and sells, a majority of the trades consists of value stocks (47.1% for buys and 50.1% for sells). The main part of both buys and sells is traded by quantitative funds. The buy transactions took place mostly in Europe, while most sell transactions were executed in the United States. The three largest industry sectors for buys are consumer discretionary, financials, and information technology. For sells the three largest sectors are consumer discretionary, industrials, and information technology (see Table I). Furthermore, a majority of both buy and sell transactions consists of agency and single trades.[6]

III Measuring the market impact of ABP trades

This section presents a further exploration of the data described in Section II in order to assess the impact of the ABP trades on prices. We start with a definition of market impact.

Market impact

To measure the market impact of trading, a benchmark price has to be chosen. We emphasize that there are several ways to do this; see Collins and Fabozzi (1991) and Chan and Lakonishok (1995) for a discussion. With a same-day benchmark, the benchmark is the volume-weighted average price calculated over all transactions in the stock on the trade day. With a pre-execution benchmark the opening price on the same day or the closing price on the previous day is used. Finally, with a post-execution benchmark the closing price of the trading day or the opening price on the next day is taken as reference price, ensuring that the temporary price impact has disappeared form the benchmark. This paper opts for the pre-execution benchmark, which is in line with e.g. Wagner and Edwards (1993). More precisely, we take as the benchmark the price at the moment that the order was passed to the broker.

Moreover, we proceed as in Chan and Lakonishok (1993, 1995, and 1997) and correct the price effects for market-wide price movements during the trade. We use the MSCI World industry group indices as a proxy for these market movements. This means that we approximate the market movement during a trade of, for instance, ABN-AMRO stocks by the movement of the MSCI World Banks index.

More precisely, for a buy transaction in stock i at day t we measure market impact costs (MIC) as follows:

$$MIC_{it}^{B} = \log(P_{it}^{exe}/P_{it}^{pt}) - \log(M_{it}^{exe}/M_{it}^{pt}), \tag{1}$$

where P_{it}^{exe} and P_{it}^{pt} denote the execution and pre-trade price of stock i at day t, respectively. M_{it}^{exe} and M_{it}^{pt} denote the value of the MSCI industry group index corresponding to stock i at the time of the execution of the trade and at the pre-trade time, respectively. In a similar way, the market impact of sells is defined as

$$MIC_{it}^{S} = \log(P_{it}^{pt}/P_{it}^{exe}) - \log(M_{it}^{pt}/M_{it}^{exe}). \tag{2}$$

For both buys and sells, positive market impact implies that a trade has been executed against a worse price than at the moment of trade initiation.

Sample properties of price effects

The first and second panel of Table V report sample means, standard deviations, medians and quantiles of the market impact for buys and sells with and without commission and correction for market-wide price movements.[7] Moreover, the first two panels of Table V provide average market impact measured on an equally-weighted average basis. The third and fourth panel of Table V report the same statistics, but computed on a principal-weighted average basis (cf. Chan and Lakonishok (1993)). The principal-weighted averages have the advantage of reflecting the market impact on a dollar-for-dollar basis, so that smaller trades contribute less to the average market impact than larger ones.

We focus on price effects and execution costs corrected for market-wide price movements. A striking difference is found between the equally-weighted average market impact for buys and sells. Buys have much more impact on prices than sells. The average price effect of buys exclusive of commission and corrected for market-wide price movements equals 16.5 bp, but that of sells is only −2.7 bp. The considerably lower magnitude of the market impact of sells is in line with the findings of Chan and Lakonishok (1993) and Keim and Madhavan (1997) and earlier studies on individual transactions by Kraus and Stoll (1972), Holthausen, Leftwich, and Mayers (1987, 1990)). Chan and Lakonishok (1993) and Saar (2001) argue that institutional selling is more often based on liquidity motives than is buying and that therefore, sells would contain less information than buys. Average execution costs (defined as the sum of commission and market impact) equal 28.7 bp for buys and 8.8 bp for sells.

On a principal-weighted average basis the results are very different. The average market impact of buys exclusive of commission and corrected for market-wide price movements equals 19.6 bp and that of sells is even larger at 25.6 bp. Average execution costs equal 27.4 bp for buys and 33.3 bp for sells. Apparently, there are some large sells that cause high price impact. On an equally-weighted average basis, these large sell orders receive a relatively low weight. Additionally, Table V demonstrates that the market impact distribution is much more skewed in the principal-weighted than in the equally-weighted average case. The substantial differences between equally and principal-weighted averages show the impact of taking into account the importance of the trade as given by its dollar value. Therefore, we will focus on the principal-weighted averages in the remaining part of this section. Note that the (value-weighted average) market impact costs of 19.6 bp for buys and 25.6 bp for sells imply total market impact costs of approximately 13 million Euro.

Table V shows that, on average, market-wide price movements are negative for buys and positive for sells. We notice that the correction for market movements can be interpreted as a proxy for the so-called delay costs. These costs reflect the risk of adverse price movements that can occur when trading is postponed. These costs are the counterpoint to market impact costs. As time increases, impact should decrease. However, as time increases, so does price variability. Waiting too long with trading can therefore increase delay costs considerably.

The literature distinguishes temporary and persistent price effects. The total market impact is computed as the sum of these two effects. As explained by Kraus and Stoll (1972), temporary price movements are caused by short-term liquidity effects (i.e. price concessions to stimulate buyers or sellers to provide liquidity), inventory effects (temporary price effects due to inventory imbalances), or imperfect substitution (price concessions to induce buyers and sellers to absorb the additional shares). The permanent impact of a trade on prices reflects the change in the perception of the market due to the information contained in a trade. Roughly speaking, a buy transaction tells the market that the stock may be underpriced, and a sell reveals that a stock may be overvalued. Market participants observe the information contained in trades and adjust their perceptions accordingly, leading to price revisions. Technically speaking, temporary price impact is defined as the log return from a post-trade moment to the trade (i.e. $\log(P_{trade}/P_{post})$), whereas the persistent price impact is measured as the log return from a pre-trade moment to a post-trade moment ($\log(P_{post}/P_{pre})$). In this way, the temporary price impact measures the price movement that is needed to provide enough liquidity to absorb the trade and the permanent price impact represents the price change due to the information contained in the trade. The temporary and persistent price impact are corrected for market-wide price movements, cf. equations (1) and (2).

Temporary and the persistent price effects (corrected for market-wide price movements) are obtained by taking the moment the trade was passed to the broker as the pre-trade moment and the closure of the market at the day after the trade as the post-trade moment. Table VI shows that, on a principal-weighted average basis, the temporary and persistent price effect of buys equal 7.2 bp and 12.4 bp, respectively. For sells, these price effects equal −15.5 bp and −11.3 bp.[8] For completeness' sake, Table VI also reports temporary and persistent price effects on an equally-weighted basis. Figures 1 and 2 show the average temporary, persistent, and total price effects for buys and sells, respectively.

To provide an indication of the standard errors of our estimates of average total, temporary, and persistent price effects Tables V and Table VI report the standard deviation of the average price effects. However, note that these are obtained under the assumption that observations are mutually uncorrelated. Therefore, true standard errors may be different.

IV Determinants of market impact

The impact of trades on prices will generally depend on various trade and stock-specific characteristics, including investment style. This section will assess the determinants of the expected market impact. Moreover, to get an idea of the market impact *risk* associated with the trades under consideration (i.e. the probability that the price effect is large), we will also analyze market impact volatility. Thus, we will assume that the market impact costs of a trade in stock i at day t have the following form:

$$MIC_{it} = \alpha' X_{it} + \sqrt{\exp(\gamma' Z_{it})}\eta_{it}. \tag{3}$$

Here $\alpha' X_{it}$ represents the conditional mean, depending on trade, market, and stock-specific factors contained in X_{it} and $\exp(\gamma' Z_{it})$ denotes the conditional variance of the market impact costs, depending on relevant characteristics contained in Z_{it}. Finally, $(\eta_{it})_{it}$ is a sequence of jointly and serially uncorrelated disturbances, with mean zero and orthogonal to the regressors in equation (3).

Conditional expectation of market impact

We will start with a simple regression model, taking market impact (excluding commission and corrected for market-wide price movements) as the dependent variable and the variables described in Section II as the regressors. Table IV provides a description of the abbreviations of the variables.[9] The full model, containing all variables under consideration, reads as:

$$\begin{aligned} MIC_{it} = & \; \alpha_1 + \alpha_2 \mathsf{Momentumperc} + \alpha_3 \mathsf{Momentumperc} \times \log(\mathsf{Volatility}) \\ & + \alpha_4 \log(\mathsf{Volatility}) + \alpha_5 \log(\mathsf{Tradesizertso}) \\ & + \alpha_6 \log(\mathsf{Tradesizertdv}) + \alpha_7 \log(\mathsf{Marketcap}) \\ & + \alpha_8 \mathsf{Agencysingledum} + \alpha_9 \mathsf{Growthdum} \\ & + \alpha_{10} \mathsf{Quantdum} + \alpha_{11} \mathsf{Eurdum} + \alpha_{12} \mathsf{Japdum} \\ & + \alpha_{13} \mathsf{Usadum} + \alpha_{14} \mathsf{Consdiscrdum} \\ & + \alpha_{15} \mathsf{Consumerstdum} + \alpha_{16} \mathsf{Energydum} + \alpha_{17} \mathsf{Findum} \\ & + \alpha_{18} \mathsf{Healthdum} + \alpha_{19} \mathsf{ITdum} + \alpha_{20} \mathsf{Materdum} \\ & + \alpha_{21} \mathsf{Telecomdum} + \alpha_{22} \mathsf{Utilitiesdum} + \varepsilon_{it}. \end{aligned} \tag{4}$$

We notice that, for simplicity of notation, we omit the subscripts for the explanatory variables in equation (4). It is assumed that the disturbances $(\varepsilon_{it})_{it}$ are jointly and serially uncorrelated. Furthermore, it is also assumed that the disturbances have mean zero and that they are orthogonal to the regressors in equation (4). The model is estimated by means of OLS using White (1980)'s heteroskedasticity consistent covariance matrix.

In line with the existing literature, the market impact of buy and sell transactions will be investigated separately. We start with analyzing buy transactions. We investigate the validity of the assumptions with respect to $(\varepsilon_{it})_{it}$ by testing whether the correlation between market impact on buy trades that took place on the same day is significant.[10] For 24 out of 25 days we do not find any significant correlation. Additionally, we test the same hypothesis for buy trades that took place during the same rebalancing period, which leads to the same conclusion.

A specification search from general to specific on the based on the Akaike information criterion leads to the following model for the market impact of buy transactions:

$$\begin{aligned} MIC^B_{it} = & \; \beta_1 + \beta_2 \mathsf{Momentumperc} + \beta_3 \mathsf{Momentumperc} \times \log(\mathsf{Volatility}) \\ & + \beta_4 \log(\mathsf{Tradesizertdv}) + \beta_5 \mathsf{Agencysingledum} \\ & + \beta_6 \mathsf{Growthdum} + \beta_7 \mathsf{Quantdum} + \beta_8 \mathsf{Usadum} \\ & + \beta_9 \mathsf{Consdiscrdum} + \beta_{10} \mathsf{Energydum} \end{aligned}$$

$$+\beta_{11}\mathsf{Telecomdum} + \beta_{12}\mathsf{Utilitiesdum} + \varepsilon_{it}. \tag{5}$$

Table VII displays the estimation results, including estimated coefficients, standard errors, and partial correlation coefficients. A partial correlation coefficient represents the partial correlation between a regressor and the dependent variable, corrected for the influence of the other regressors. The partial correlation coefficient is a measure of that part of the variance in the dependent variable that is not explained by other determinants and can therefore be interpreted as an indication of the relative importance of a regressor.

Intuitively, when the price of a stock has recently moved upwards, it is more likely that buy order will have increased impact while a sell order will have a reduced impact on prices. We would therefore expect the impact of momentum on the market impact of buy transactions to be positive, since high momentum indicates a buying trend. However, the estimation results document a more complicated relation between momentum and market impact, including a role for volatility. The coefficient of momentum is significantly negative, but the coefficient of the product of momentum and volatility is significantly positive. This means that momentum affects market impact through the volatility-dependent coefficient $\beta_2 + \beta_3 \log(\mathsf{Volatility})$, with β_2 significantly negative and β_3 significantly positive. This means that, ceteris paribus, the impact of momentum will only be negative when volatility is low. The relation between market impact, momentum, and volatility can be explained as follows. When momentum and volatility are both high, this is a signal to the market that there is positive news in the air. However, when volatility is relatively low, a buying trend may be caused by effects that are not related to asymmetric information. Hence, in the latter situation high momentum does not have the positive impact on market impact that it would have when volatility is high.

The coefficient corresponding to relative trade size is significantly positive. Therefore, market impact is higher the larger the trade. Since higher trading volume reflects a higher degree of trade difficulty (see Keim and Madhavan (1997)), the liquidity costs of larger buy trades are also higher. As a consequence, larger buy trades have higher temporary price impact. Moreover, according to Easley and O'Hara (1987) large buy trades convey more information. As a consequence, the permanent price impact of a trade depends positively on the size of the trade. Additional empirical evidence for the positive relation between trading volume and price effects has been established by Spierdijk, Nijman, and Van Soest (2003) and Keim and Madhavan (1997).

The dummy variable for agency/single and principal trades has a significantly positive coefficient and a value of 36.6. This means that, ceteris paribus, the market impact is 36.6 bp higher for agency and single trades than for principal trades. This outcome is consistent with the empirical results established by Smith, Turnbull, and White (2001). They explain the higher market impact of agency trades by noticing that brokerage firms are interested in maintaining their reputation capital. Therefore, the visibility of their price impacts and the importance of the broker-client relationships prevents them from cream-skimming their clients. This would imply that the price impact of agency and single trades is typically higher than that of principal trades. We notice that part of the difference in market impact between agency/single and principal trades disappears when commission is taken into account. When we run the same regression with market impact *including* commission as dependent variable, the dummy variable for agency/single and principal trades remains significant, but its coefficient drops to 18.6. This is due to the fact that commission also depends on the type of trade. For agency trades fee rates equal 2−8 bp, for single trades 10 bp, while principal trades carry fee rates above 10 bp.

It should also be noted that the regression analysis in this section is on an *ex post* basis; that is, based on observations after the trade has been executed. This is an important distinction to make, since, on an *ex ante* basis, the phenomenon of selectivity bias will be encountered (which would require a different estimation technique). To see this, note that it is up to the pension fund itself to decide whether it wants to trade on an agency, single, or principal basis. This is where the selectivity bias comes in, caused by the fact that the pension fund's choice for either a principal, agency, or single trade will affect the expected market impact of the trade, which, in turn, is one of the determinants of the initial choice for a principal, agency, or single trade. Since the focus of this paper is on the price effects of trades that have actually taken place (seen from the perspective of the regulator), we are interested in the market impact on an ex post basis. As a consequence, the coefficient of the agency/single dummy does *not* indicate the difference in market impact relative to the trade having been a principal trade. The coefficient only reflects the difference in market impact between the realized agency/single and principal trades. In a model that takes into account selectivity bias (see, for instance, Lee, Maddala, and Trost (1979) and Chang and Madhavan (1997)), the pension fund would in fact be able to estimate the effect on the market impact of choosing an agency/single trade instead of a principal trade and vice versa.

The value/growth dummy is significantly positive. This can be explained by noticing that growth stocks are usually considered more risky than value stocks. The coefficient of the dummy indicating whether the trade comes from a quantitative or a fundamental fund is significantly negative, which means that trades by quantitative funds have lower market impact than comparable trades by fundamental funds. This finding does not coincide with those of Chan and Lakonishok (1993, 1995) or Keim and Madhavan (1997). The latter authors show that the market impact is higher as the demand for immediacy in the investment style increases, which they explain from the fact that investors with a short-term perspective are willing to pay the price for immediacy. Therefore, we would expect higher market impact for trades done by quantitative funds, since the latter type of fund trades with much more urgency than fundamental funds. Yet if we correct for the trade duration (i.e. the time that elapses between the moment the trade is passed to the broker and the moment the trade has been executed) the apparent anomaly disappears: in this case the dummy variable distinguishing quantitative and fundamental funds is no significant anymore. The correction for trade duration demonstrates that, for buys, longer trade duration implies higher market impact. This is in line with Section III, where we showed that delay costs are negative for buys. Since the trades of fundamental funds take longer to execute on average (5.5 hours versus 3.4 hours), this explains the negative coefficient of the dummy that distinguishes quantitative and fundamental funds.[11]

The country dummy in regression equation (5) captures country-related effects on the market impact that are unrelated to the remaining regressors. Since the coefficient of the country dummy for the United States is significantly negative, buy trades in the United States have lower market impact than comparable trades in Canada, Japan, and Europe. This result is likely to reflect the higher liquidity of the stock market in the United States. The sector dummies in equation (5) reflect sector-specific effects on the market impact unrelated to the other regressors. Since the coefficients of the sector dummies are significantly positive, buy trades in stocks belonging to the consumer discretionary, energy, telecommunications, and utilities sectors have higher market impact than buy trades in comparable stocks in other sectors.

The partial correlation coefficients suggest that the product of momentum and volatility, the dummy variable distinguishing agency/single and principal trades, and momentum contribute most to explaining the market impact of buys.

For sells we proceed in the same way as for buys. The specification search yields the following model for the market impact of sells:

$$\begin{aligned} MIC_{it}^{S} = {} & \beta_1 + \beta_2 \mathsf{Momentumperc} \times \log(\mathsf{Volatility}) \\ & + \beta_3 \log(\mathsf{Volatility}) + \beta_4 \log(\mathsf{Tradesizertso}) \\ & + \beta_5 \log(\mathsf{Tradesizertdv}) + \beta_6 \log(\mathsf{Marketcap}) \\ & + \beta_7 \mathsf{Quantdum} + \beta_8 \mathsf{Eurdum} + \beta_9 \mathsf{Japdum} \\ & + \beta_{10} \mathsf{Consdiscrdum} + \beta_{11} \mathsf{Consumerstdum} \\ & + \beta_{12} \mathsf{Energydum} + \beta_{13} \mathsf{Findum} + \beta_{14} \mathsf{Healthdum} \\ & + \beta_{15} \mathsf{ITdum} + \beta_{16} \mathsf{Materdum} \\ & + \beta_{17} \mathsf{Quantdum} \times \mathsf{Usadum} + \varepsilon_{it}. \end{aligned} \tag{6}$$

Again we assume that the disturbances $(\varepsilon_{it})_{it}$ are jointly and serially uncorrelated,[12] that they have mean zero and that they are orthogonal to the regressors in equation (6).

Table VIII displays the estimation results for sells. The results show that momentum determines the relation between market impact and volatility. The coefficient of log volatility is momentum-dependent and equals $\beta_3 \mathsf{Momentumperc} + \beta_4$, with β_3 significantly negative and β_4 significantly positive. This means that the impact of volatility will only be negative when momentum is very high; i.e. when there is a buying trend. In such a situation high volatility is offset by high momentum. When momentum is low, volatility has a positive impact on market impact. This can be explained by the fact that stocks with higher volatility suffer from higher (permanent) price effects, since trades are more informative when volatility is high (see Chan and Lakonishok (1997) and Smith, Turnbull, and White (2001)).

Since the trade size is measured both relative to daily volume and shares outstanding, we examine the joint instead of the individual significance of these coefficients. A Wald-test shows that the coefficients are not jointly significant. Moreover, note that the marginal effect of trade size in lots is given by $\gamma_{lots} = \gamma_4 + \gamma_5$, which is not significant either.

Market capitalization has a significantly negative coefficient, which implies that selling large cap stocks causes less market impact than selling small cap stocks. This is in line with the findings of, for instance, Hasbrouck (1991a, 1991b), Keim and Madhavan (1997) and Spierdijk, Nijman, and Van Soest (2002). However, Chan and Lakonishok (1993, 1995) show that the importance of firm size disappears in the presence of variables related to investment style. Since the model in expression (5) also contains such variables (the dummy variables Quantdum and Quantdum×Usadum), this could explain why market capitalization does not play a very important role in explaining expected market impact (which is reflected by its low partial correlation coefficient).

The coefficient of the dummy indicating whether the sell comes from a quantitative or a fundamental fund is significantly positive, hence trades by quantitative funds cause more market impact. This is in line with Chan and Lakonishok (1993, 1995) and Keim and Madhavan (1997).

The country dummies are significantly negative and also jointly significant. This means that − relative to sells in Canada and the United States − sells Europe and Japan lead to lower market impact. With respect to the sector dummies, Table VIII shows that trades in stocks belonging to the consumer discretionary, energy, financials, and materials sectors have significantly lower market impact. The market impact of trades in stocks in the consumer staples, health, and IT sector is not significantly different from similar trades in other sectors.

The product of the country dummy for the United States and the dummy variable distinguishing quantitative and fundamental trades is significantly negative. Hence, trades by quantitative funds in the United States have significantly lower market impact than similar trades by quantitative funds in Europe, Japan, and Canada.

The partial correlation coefficients show that the dummy variable distinguishing quantitative and fundamental funds, followed by the product of momentum and volatility and the country dummy for trades in Europe play the most important role in explaining the market impact of sells.

Conditional variance of market impact

For the conditional variance of the market impact, we regress the (realized) squared residuals in logarithms (i.e. $\log(e_{it}^2)$) on the variables given in equation (4) and follow the same model selection principle as before. For buys the specification search leads to the model

$$\begin{aligned}\log(e_{it}^2) \quad = \quad & \gamma_1 + \gamma_2 \log(\mathsf{Volatility}) + \gamma_3 \log(\mathsf{Tradesizertso}) \\ & + \gamma_4 \log(\mathsf{Tradesizertdv}) + \gamma_5 \mathsf{Agencysingledum} \\ & + \gamma_6 \mathsf{Eurdum} + \gamma_7 \mathsf{Usadum} + \gamma_8 \mathsf{ITdum} + \eta_{it}. \end{aligned} \tag{7}$$

The model is estimated by means of OLS using White (1980)'s heteroskedasticity consistent covariance matrix. The estimation results for buys can be found in Table IX.

Volatility has a significantly positive impact on market impact. This means that there is more variability in market impact in periods when price fluctuations are higher.

The coefficients of the variables related to trade size are jointly significant. The sum of their coefficients (i.e. $\gamma_{lots} = \gamma_3 + \gamma_4$) reflects the marginal impact of the number of shares on market impact volatility and is significantly positive. Hence, there are more fluctuations in the market impact costs of large buys than of comparable buys of smaller size.

The dummy for the type of trade (agency/single versus principal) is significantly positive, hence the market impact of agency and single trades shows more fluctuations than the market impact of principal trades. Again this can be explained by the fact that principal trades benefit from the broker's wish to maintain his reputation. The broker will therefore try to avoid excessive price effects of principal trades, leading to less variability in the market impact costs of this type of trades.

The coefficients of the country dummies for Europe and the United States are significantly negative, hence buys in these countries cause less fluctuations in market impact than similar trades in Canada and Japan. The significantly positive coefficient of the sector dummy for the IT sector, indicates that trades in stocks belonging to this sector cause more fluctuations in market impact than comparable trades in stocks belonging to other sectors.

The partial correlation coefficients show that the country dummies for the United States and Europe contribute most to explaining the market impact volatility of buys, followed by trade size relative to shares outstanding.

By proceeding in a similar way, the following specification for sells is found:

$$
\begin{aligned}
\log(e_{it}^2) &= \gamma_1 + \gamma_2 \log(\mathsf{Volatility}) + \gamma_3 \log(\mathsf{Tradesizertso}) \\
&\quad + \gamma_4 \log(\mathsf{Tradesizertdv}) + \gamma_5 \log(\mathsf{Marketcap}) \\
&\quad + \gamma_6 \mathsf{Agencysingledum} + \gamma_7 \mathsf{Growthdum} + \gamma_8 \mathsf{Quantdum} \\
&\quad + \gamma_9 \mathsf{Eurdum} + \gamma_{10} \mathsf{Japdum} + \gamma_{11} \mathsf{Usadum} + \gamma_{12} \mathsf{Energydum} \\
&\quad + \gamma_{13} \mathsf{Materdum} + \gamma_{14} \mathsf{Telecomdum} + \eta_{it}. \qquad (8)
\end{aligned}
$$

The estimation results for sell transactions are displayed in Table X. Volatility has a significantly positive coefficient. This means that there is greater market impact variability during periods when there is more fluctuations in prices anyhow. The coefficients corresponding to the trade-related variables are jointly significant. The marginal effect of trade size in lots is given by $\gamma_{lots} = \gamma_3 + \gamma_4$, which is positive but not significant. Market capitalization has a significantly negative coefficient, implying that trades in large cap stocks have less fluctuations in market impact than trades in small cap stocks.

The coefficient of the trade type dummy (agency, single or principal) has a significantly positive value: agency and single trades have more fluctuations in market impact than principal trades. The same result was found for the conditional variance of buys. The type of stock dummy (value or growth) is significantly positive, indicating that growth stocks cause more fluctuations in market impact. This can be explained by noticing that growth stocks are usually more volatile than value stocks. The type of fund dummy (quantitative versus fundamental fund) is significantly negative, hence the sells by quantitative funds cause less variability in market impact. Hence, although, sells by quantitative funds cause higher market impact on average, they cause less variability in market impact.

The country dummies are significantly positive and jointly significant. Thus, sell transactions in Europe, Japan, and the United States cause more fluctuations in market impact than sells in Canada. The coefficients of the sector dummies for energy and telecommunications are significantly positive. Trades in stocks in the materials sector do not have significantly different market impact than comparable trades in other sectors.

From the partial correlation coefficients we can deduce that the dummy variable for quantitative and fundamental funds plays the most important role in explaining market impact volatility of sells. Other important variables are the dummy for agency/single and principal trades and the country dummy for Europe.

Table XI reports the most important determinants of expected market impact and market impact volatility of both buys and sells, based on the partial correlation coefficients.

V Conclusions

This paper has used a unique data set to investigate market impact and execution costs of equity trading by ABP, a major pension fund in the Netherlands. We have found that, on average, these costs are nonnegligible. Average market impact costs equal 20 basis points for buys and 26 basis points for sells; average execution costs (defined as the sum of commission and market impact) equal 27 basis points and 33 basis points, respectively.

The data, containing detailed information on all worldwide equity trades of ten different funds at ABP during the first quarter of 2002, have been used to identify the trade and stock-specific characteristics that determine market impact costs. For buys, the stock-specific characteristics momentum and price volatility play a crucial role in explaining the price effects of trading. Expected price effects are larger when momentum and volatility are high and market impact costs exhibit more fluctuations when price volatility is high. Moreover, the type of trade is also an important determinant of the market impact costs. Agency and single trades have higher expected price impact than comparable principal trades. Furthermore, agency and single trades also have higher volatility of market impact costs. The trading venue is another variable that considerably affects the variability of market impact costs of buys. For sells we find partly different results. The investment style of the fund − determining the demand for immediacy of the trade − has much influence on both the expected market impact and the volatility of these costs. Trades by quantitative funds that focus on growth strategies affect prices more than trades by fundamental funds that use value strategies. Moreover, the market impact costs of sells done by quantitative funds show less fluctuations than comparable trades done by fundamental funds. As for buys, the volatility of the price effect of agency and single trades is higher than that of comparable principal trades. Additionally, the expected price effects of sells are larger when volatility is high and momentum is low. High price volatility also leads to more fluctuations in the market impact costs of sells. Moreover, the trading venue also plays an important role in explaining expected market impact costs as well as fluctuations in these costs.

The results make clear that relative trade size and market capitalization − variables that are often found to be significantly related to price effects in the existing literature − do have some influence on market impact costs. However, they are considerably less important than momentum, stock price volatility, investment style, trade type (agency, single, or principal), and trading venue. This is partly in line with Chan and Lakonishok (1993, 1995), who find that the importance of trade size and market capitalization pales beside the importance of investment style. The important role of the trading venue in explaining market impact impact coincides with the findings of Domowitz, Glen, and Madhavan (2002), who document wide variation in equity trading costs across countries.

Notes

[1]Source: NYSE Fact Book 2001. See www.nyse.com.

[2]This is the invested capital of ABP d.d. March 31, 2004.

[3]Trades that were split up into several sub trades are considered as one single trade, if a trader at ABP decided to split up the trade. The data contain about 0.5% of such 'trade packages'. Orders split up by portfolio managers will be treated as individual trades, since it is not known whether the trader eventually split the trade in the same way the portfolio managers did.

[4]Note that the data are biased with respect to trading volume, since trades larger than 25% of the average daily volume in the stock under consideration are not allowed (with the average daily volume measured over the past twenty trading days).

[5]Some stocks do no belong to either of these two categories.

[6]Agency and single trades have been aggregated, since there are too few single trades to treat them as a distinct class. It is natural to aggregate agency and single trades, since these are the trades that the broker acts as an agency for.

[7]Since we only have closing prices of the MSCI industry group indices, we approximate the market-wide price movements in expressions (1) as

$$\frac{dur_{it}}{8}\log\Big(M_{it}^{pdc}/M_{it}^{close}\Big),$$

where M_{it}^{pdc} and M_{it}^{close} denote the previous day closing price and the closing price of the MSCI industry group index of stock i at day t and dur_{it} represents the number of hours it took to complete the trade in stock i at day t. Hence, we assume that there are eight hours in a trading day. Under this assumption we can say that, given the fact that an index rose by 100 bp on a certain day, the expected price change of that index during a one-hour period is 12.5 bp. If, for example, it took four hours to complete a trade, we will correct the price effect for market movements by subtracting fifty percent of the price change in the index during the day of the trade. A further assumption we will have to make is that overnight price movements, which are also included in the index return over the one-day period, are negligible. For the market-wide price movements of sells in expression (2) we use the same approximation.

[8]We compute the sample statistics of the temporary and persistent price effects for a slightly smaller sample than we used to obtain the sample statistics of the market impact. This is because, for some trades, we did not have enough data on the prices around the time of the trade. Eventually, we have computed the average temporary and persistent price effects on the basis of 1,935 buy trades and 1,746 sell trades. As a consequence, the sum of both temporary and persistent price effects (i.e. the total price effect) is not exactly equal to the previously computed market impact.

[9]One regional- and one sector dummy have been omitted in the regressions to avoid perfect collinearity. Furthermore, we did not find any evidence for multicollinearity in the remaining analysis.

[10]In the sequel, the significance level will be 5%, unless stated differently.

[11]We do not include trade duration in our regression, since we only include variables that are known *before* a trade is passed to the broker. Since the trade duration is only known *after* the trade has been executed, we feel that it is inappropriate to include this variable in the information set.

[12] As for buys, we investigate the validity of this assumption for sell transactions, but we do not find any significant correlation.

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sector name	**MSCI industry groups**
Consumer Discretionary Sector	Automobiles and Components, Consumer Durables and Apparel, Hotels, Restaurants and Leisure, Media, Retail
Consumer Staples Sector	Food & Drug Retailing, Food, Beverage & Tobacco, Household & Personal Products
Energy Sector	Energy
Financials Sector	Banks, Diversified Financials, Insurance, Real Estate
Information Technology Sector	Software & Services, Technology Hardware
Industrials Sector	Capital Goods, Commercial Services & Supplies, Transportation
Health Sector	Health Care Equipment & Services, Pharmaceuticals & Biotechnology
Materials Sectors	Materials
Telecommunications Services Sector	Telecommunication Services
Utilities	Utilities

Table I: Sector names and constituent industry groups. Source: MSCI Global Industry Classification Standard.

buys (unit)	**duration** (hours)	**# shares**	**commission** (bp)	**trade size rtdv*** (%)	**trade size rtso**** (%)	**trade value** (Euro)	**input value***** (Euro)
mean	3.96	70,303	12.2	4.29	0.02	1,464,844	1,464,363
st.dev.	2.44	198,535	10.0	8.60	0.03	2,799,983	2,797,021
median	4.75	14,428	8.0	1.32	0.01	305,958	306,796
0.5% quantile	0.22	4	2.0	9.92e-04	4.42e-06	269	268
5% quantile	0.50	169	2.0	0.02	9.57e-05	3,852	3,839
95% quantile	6.50	305,197	29.0	14.54	0.07	6,813,513	6,834,569
99.5% quantile	6.75	1,116,399	50.0	56.22	0.16	17,188,953	17,475,886
sells							
mean	4.50	84,132	11.53	3.41	0.02	1,597,814	1,605,437
st.dev.	2.40	249,622	9.84	6.42	0.04	2,916,597	2,934,101
median	5.95	17,457	8.00	1.33	4.47e-03	349,341	351,763
0.5% quantile	0.50	14	2.00	3.52e-03	2.19e-05	797	798
5% quantile	0.50	170	2.00	0.02	9.54e-05	6,025	6,011
95% quantile	6.50	306,861	29.00	12.25	0.08	7,950,280	7,982,833
99.5% quantile	6.75	1,363,861	29.00	41.60	0.30	16,646,239	16,922,149

Table II: Trade-specific characteristics of buy and sell transactions

∗ Trade size rtdv stands for trade size *relative to daily volume*.

∗∗ Trade size rtso refers to trade size *relative to shares outstanding.*

∗ ∗ ∗ Input value refers to the Euro value of the trade at the moment that the trade is passed to the broker.

buys					
	Quantdum	Candum	Japdum	Eurdum	Usadum
mean (in %)	73.0	8.8	15.9	41.0	34.3
st.dev. (in %)	44.4	28.4	36.6	49.2	47.5
	Findum	Telecomdum	Energydum	ITdum	Utilitiesdum
mean (in %)	13.8	3.4	4.3	11.5	5.4
st.dev. (in %)	34.5	18.2	20.4	31.9	22.5
	Consdiscrdum	Healthdum	Consumstdum	Materdum	Industrydum
mean (in %)	20.8	7.9	4.7	8.9	19.2
st.dev. (in %)	40.6	27.0	21.1	28.5	39.4
sells					
	Quantdum	Candum	Japdum	Eurdum	Usadum
mean (in %)	66.5	3.6	27.0	27.8	41.7
st.dev. (in %)	47.2	18.6	44.4	44.8	49.3
	Findum	Telecom	Energydum	ITdum	Utilitiesdum
mean (in %)	18.7	3.8	3.1	15.7	5.3
st.dev. (in %)	39.0	19.1	17.3	36.4	22.4
	Consdiscrdum	Healthdum	Consumerstdum	Materdum	Industrydum
mean (in %)	20.1	6.6	7.7	7.7	11.2
st.dev. (in %)	40.1	24.8	26.7	26.6	31.5

Table III: Characteristics of buy and sell transactions: type of portfolio, type of trade, region, and sector

The abbreviations of the variable names are explained in Table IV.

variable	**description**
Momentumperc	momentum computed over the last five trading days (in %)
Volatility	price volatility computed over the last thirty trading days
Tradesizertso	trade size relative to shares outstanding (in %)
Tradesizertdv	trade size relative to daily volume (in %)
Marketcap	market capitalization (in Euro)
Commissionbp	commission (in bp)
Agencysingledum	dummy for agency or single (= 1) or principal (= 0) trade
Growthdum	dummy for growth (= 1) or value (= 0) stock
Quantdum	dummy for trade done by quantitative (= 1) or fundamental (= 0) fund
Eurdum	dummy for trade in Europe
Japdum	dummy for trade in Japan
Usadum	dummy for trade in the United States
(Candum)	(dummy for trade in Canada)
Consdiscrdum	dummy for consumer discretionary sector
Consumerstdum	dummy for consumer staples sector
Energydum	dummy for energy sector
Findum	dummy for financial sector
Healthdum	dummy for health sector
(Industrydum)	dummy for industrials sector)
ITdum	dummy for IT sector
Materdum	dummy for materials sector
Telecomdum	dummy for media sector
Utilitiesdum	dummy for energy sector

Table IV: Descriptions of the variables and their abbreviations

One region- and one sector dummy (in parentheses) have been omitted in the regressions in equations (4),(5), (6), (7), and (8) to avoid exact collinearity.

buys (equally-weighted)	market impact (incl. MWPM)	execution costs (incl. MWPM)	execution costs (excl. MWPM)	market impact (excl. MWPM)
mean	4.4	16.6	28.7	16.5
st.dev. mean	2.6	2.6	2.7	2.7
st.dev.	113.5	114.2	119.3	119.5
median	0.0	19.7	26.5	7.9
quantile 0.5%	−410.2	−405.2	−389.0	−391.5
quantile 5%	−149.8	−143.5	−154.6	−163.0
quantile 95%	165.1	171.7	208.7	201.9
quantile 99.5%	489.1	497.1	509.0	501.6
sells (equally-weighted)				
mean	20.9	32.4	8.8	−2.7
st.dev. mean	3.5	3.5	3.7	3.7
st.dev.	148.1	146.8	153.8	154.2
median	5.9	27.5	17.4	2.2
quantile 0.5%	−507.4	−499.4	−528.6	−536.6
quantile 5%	−179.6	−171.9	−242.1	−251.8
quantile 95%	244.1	250.0	218.4	210.5
quantile 99.5%	605.4	607.4	559.7	557.3
buys (principal-weighted)				
mean	3.9	11.6	27.4	19.6
st.dev. mean	5.3	5.4	5.7	5.7
st.dev.	235.6	238.4	254.2	251.3
median	0.0	0.8	1.1	0.2
quantile 0.5%	−1,056.5	−1,046.8	−922.8	−942.8
quantile 5%	−171.7	−155.4	−123.1	−133.1
quantile 95%	174.8	207.0	265.7	241.6
quantile 99.5%	993.6	1,024.8	1,341.9	1,329.6
sells (principal-weighted)				
mean	45.5	53.3	33.3	25.6
st.dev. mean	7.7	7.7	6.9	6.9
st.dev.	325.2	323.5	290.0	291.8
median	0.1	2.1	0.4	0.0
quantile 0.5%	−1,211.8	−1,148.0	−1,011.9	−1,052.8
quantile 5%	−129.3	−111.2	−145.8	−158.9
quantile 95%	431.5	440.6	372.4	353.8
quantile 99.5%	1,901.9	1,914.3	1,434.0	1,420.2

Table V: Market impact and execution costs for buys and sells (in bp)

Execution costs are defined as the sum of commission and market impact costs. Both market impact and execution costs are given with and without correction for market-wide price movements (abbreviated as MWPM).

	temporary (equally-weighted)	persistent (equally-weighted)	temporary (principal-weighted)	persistent (principal-weighted)
buys				
mean	0.4	16.3	7.2	12.4
st.dev. mean	7.2	7.8	10.5	12.1
st.dev	317.6	341.2	461.3	532.8
median	−0.6	23.6	0.0	0.4
quantile 0.5%	−925.4	−1039.9	−2024.0	−2028.2
quantile 5%	−446.8	−434.5	−383.0	−398.3
quantile 95%	418.8	475.7	418.5	509.6
quantile 99.5%	855.1	1206.6	2345.1	2463.6
sells				
mean	−7.8	10.6	−15.5	−11.3
st.dev. mean	8.7	9.3	9.7	11.7
st.dev	364.6	388.9	403.9	489.5
median	−1.4	−4.9	0.0	−0.1
quantile 0.5%	−1377.3	−1284.7	−1837.2	−2464.1
quantile 5%	−502.3	−490.3	−487.8	−553.6
quantile 95%	453.6	601.4	360.4	477.8
quantile 99.5%	1216.5	1343.2	1703.9	1912.2

Table VI: Temporary and persistent price effects of buys and sells (in bp), corrected for market-wide price movements

variable	coeff.	st.dev.	PCC
const	27.9	9.0	
Momentumperc	−82.7	32.3	−0.12
Momentumperc*log(Volatility)	26.9	9.3	0.15
log(Tradesizertdv)	3.1	1.2	0.05
Agencysingledum	36.6	6.6	0.13
Growthdum	14.6	5.3	0.06
Quantdum	−21.9	7.0	−0.08
Usadum	−52.1	7.5	0.00
Consdiscrdum	17.2	6.3	0.06
Energydum	44.9	12.9	0.08
Telecomdum	37.8	13.5	0.06
Utilitiesdum	23.0	10.1	0.05
R^2	0.12		
adj. R^2	0.11		
Akaike	12.29		

Table VII: Estimation results for buys (conditional expectation)

The standard errors are obtained using White (1980)'s heteroskedasticity consistent covariance matrix. The column captioned 'PCC' reports partial correlation coefficients.

variable	coeff.	st.dev.	PCC
const	−51.7	48.7	
Eurdum	−119.5	16.0	−0.19
Japdum	−98.6	14.3	−0.19
Quantdum	137.9	14.1	0.28
Momentumperc*log(Volatility)	−4.4	1.1	−0.21
log(Volatility)	26.6	8.9	0.10
log(Tradesizertso)	−10.0	4.6	−0.06
log(Tradesizertdv)	10.4	4.8	0.06
log(Marketcap)	−9.9	3.1	−0.09
Consumerdiscrdum	−37.2	9.2	−0.09
Consumerstdum	26.0	16.6	0.04
Energydum	−38.9	14.4	−0.05
Findum	−36.2	9.4	−0.08
Healthdum	−21.4	11.1	−0.04
Ictdum	−19.3	13.9	−0.04
Materdum	−32.6	12.1	−0.06
Quantdum*Usadum	−61.7	17.4	−0.10
R^2	0.19		
adj. R^2	0.19		
Akaike	12.58		

Table VIII: Estimation results for sells (conditional expectation)

The standard errors are obtained using White (1980)'s heteroskedasticity consistent covariance matrix. The column captioned 'PCC' reports partial correlation coefficients.

variable	coeff.	st.dev	PCC
const	8.77	0.62	
log(Volatility)	0.38	0.10	0.08
log(Tradesizertso)	0.31	0.06	0.12
log(Tradesizertdv)	−0.24	0.06	−0.09
Agencysingledum	0.83	0.21	0.09
Usadum	−1.22	0.14	−0.18
Eurdum	−1.71	0.24	−0.17
Ictdum	0.49	0.17	0.07
R^2	0.22		
adj. R^2	0.21		
Akaike	4.42		

Table IX: Estimation results for buys (conditional variance)

The standard errors are obtained using White (1980)'s heteroskedasticity consistent covariance matrix. The column captioned 'PCC' reports partial correlation coefficients.

variable	coeff.	st.dev.	PCC
const	8.04	0.85	
Usadum	1.54	0.36	0.11
Eurdum	0.95	0.44	0.05
Japdum	1.41	0.35	0.10
Growthdum	0.35	0.13	0.07
Quantdum	−1.12	0.15	−0.17
Agencysingledum	1.16	0.19	0.12
log(Volatility)	0.38	0.12	0.08
log(Tradesizertso)	0.31	0.07	0.10
log(Tradesizertdv)	−0.28	0.07	−0.10
log(Marketcap)	−0.15	0.05	−0.07
Energydum	0.56	0.24	0.04
Materdum	0.35	0.24	0.04
Telecomdum	0.91	0.24	0.07
R^2	0.20		
adj. R^2	0.19		
Akaike	4.49		

Table X: Estimation results for sells (conditional variance)

The standard errors are obtained using White (1980)'s heteroskedasticity consistent covariance matrix. The column captioned 'PCC' reports partial correlation coefficients.

	expected	**volatility**
buys	momentum×volatility	country dummy United States
	dummy for agency/single/principal trades	country dummy Europe
	momentum	trade size relative to shares outstanding
sells	dummy for quantitative/fundamental funds	dummy for quantitative/fundamental funds
	momentum×volatility	dummy for agency/single principal trades
	country dummy Europe	country dummy United States

Table XI: The most important determinants of expected market impact and market impact volatility.

The partial correlation coefficients in Tables VII, VIII, IX, and X have been used to establish the most important determinants of expected market impact and market impact volatility.

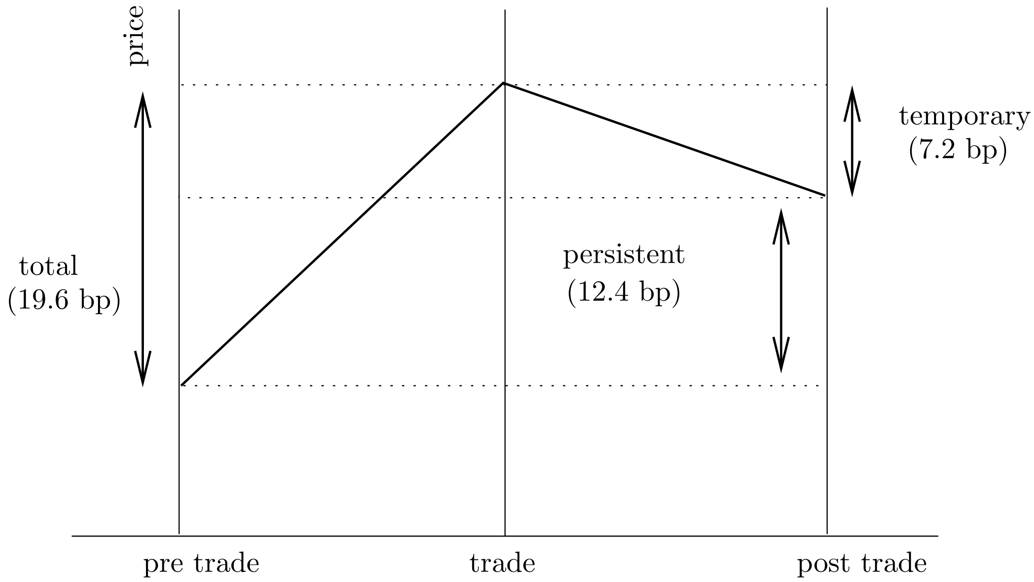

Figure 1: The average temporary, persistent, and total price effects for of buys (in bp)

This plot shows the average temporary, persistent, and total price effects of buys in bp (corrected for market-wide price movements). According to this figure, the temporary price effect (the return from the post-trade moment to the trade) is positive, as it is measured as the decline in the price after the trade. The price drops after a buy, since the liquidity effect on the price dies out. The permanent price effect (the return from the pre-trade moment to the post-trade moment) is also positive: the price at the post-trade moment is higher than at trade initiation, due to the information content of the buy. As a consequence, the total price effect − obtained as the sum of the temporary and persistent price effects − is positive as well.

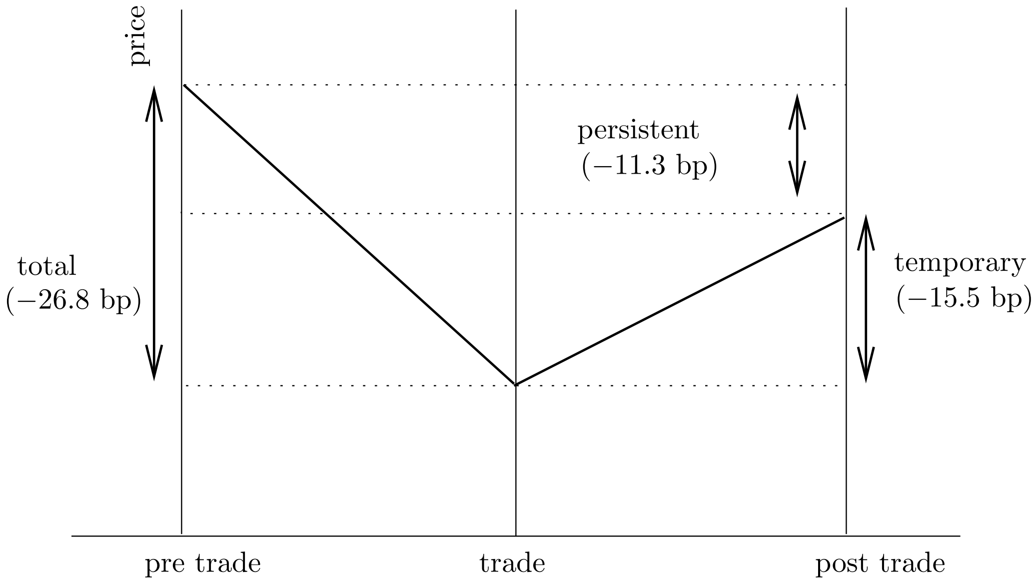

Figure 2: The average temporary, persistent, and total price effects of sells (in bp)

This plot shows the average temporary, persistent, and total price effect for sells in bp (corrected for market-wide price movements). According to this figure, the temporary price effect (the return from the post-trade moment to the trade) is negative, as it is measured as the increase in the price after the trade. Usually, the price increases after a sell, since the liquidity effect on the price dies out. The permanent price effect (the return from the pre-trade moment to the post-trade moment) is also negative: the price at the post-trade moment is lower than at trade initiation, due to the information content of the sell. As a consequence, the total price effect − obtained as the sum of the temporary and persistent price effects − is negative as well.