Minority Shareholder Expropriation and Asymmetric Information Flows in a Global Registered Share: The Saga of Daimler Chrysler

Finance Working Paper N°. 60/2004
December 2004

Frederick H. deB. Harris
Wake Forest University

Sherry L. Jarrell
Wake Forest University

Thomas H. McInish
University of Memphis

Robert A. Wood
University of Memphis

ECGI Working Paper Series in Finance

Minority Shareholder Expropriation and Asymmetric Information Flows in a Global Registered Share: The Saga of Daimler Chrysler

Working Paper N°. 60/2004

December 2004

Frederick H. deB. Harris
Sherry L. Jarrell
Thomas H. McInish
Robert A. Wood

This research was supported by ISSM and the Research Grants Program of the Babcock Graduate School of Management, Wake Forest University. For advice and commentary, we wish to thank Rob Bliss, Stephan Bryan, John Coffee, Rich Green, Rob Nash, Steve Nickles, Bruce Resnick and participants at the 2002 International FMA Conference in Copenhagen, Ulrich Schroder at Deutsche Bank, and Mark Andereas Weth at the FSE.

Abstract

The Daimler foray into the international equity market, beginning with its 1993 cross-listing in the U.S. and peaking with its 1998 merger with Chrysler, provides an uncommon opportunity to explore the interplay between competing approaches countries may take in their treatment of minority shareholders. In the common-law approach often adopted in the U.K, present and former Commonwealth countries, Israel and the U.S., strict disclosure and reporting requirements are combined with strong corporate governance standards on board structure, incentive-based executive compensation, and voting rights to protect minority shareholders from expropriation by controlling shareholders and principal creditors. In contrast, as a cross-listed German stock corporation, DaimlerChrysler's civil-law approach to governance was dominated by direct monitoring by controlling shareholders and principal creditors who imposed strict internal accounting standards and extraordinary confidentiality designed to prevent the leakage of asymmetric information to minority shareholders. In this paper we use the DaimlerChrysler events to generate unique evidence on the extent to which two methods – disclosure requirements and corporate governance standards – can substitute for one another in protecting minority shareholders from expropriation. We find that strict disclosure requirements, though they provide measurable reductions in asymmetric information, are an insufficient substitute for strong corporate governance measures. Strict disclosure complements strong corporate governance, and both may be required to create environments in which firms can raise capital and fund growth opportunities most efficiently.

Keywords: cross-listing, corporate governance, disclosure, minority shareholder, order flow, trading costs, price discovery

JEL Classifications: G34, G14, G15

Frederick H. deB. Harris
Babcock Graduate School of Management, Wake Forest University
Winston-Salem, NC 27109
phone: 336-758-5112
e-mail: rick.harris@mba.wfu.edu

Sherry L. Jarrell*
Babcock Graduate School of Management, Wake Forest University
Winston-Salem, NC 27109
phone: 336-758-6143
e-mail: sherry.jarrell@mba.wfu.edu

Thomas H. McInish
College of Business and Economics, University of Memphis
Memphis, TN 38152
phone: 901-678-4662
e-mail: tmcinish@memphis.edu

Robert A. Wood
College of Business and Economics, University of Memphis
Memphis, TN 38152
phone: 901-678-2670
e-mail: rawood@pobox.com

*Corresponding author

1. Introduction

Large shareholders typically control European and Asian industrial giants (La Porta, Lopez-de-Silanes, and Shleifer, 1999), and in such firms minority shareholder interests are less well protected than under U.S. securities law and listing requirements (Coffee, 2002). Daimler-Benz was no exception. In 1993, Deutsche Bank owned 24% of its shares, Mercedes AG Holding owned 25%, and the Emirate of Kuwait owned 14%. And in a study of the extent of the legal protection afforded minority shareholders across 27 countries worldwide, German shareholder protection ranked among the very worst (La Porta, Lopez-de-Silanes, Shleifer and Vishny, 2002). It was amidst this harsh minority shareholder environment that Daimler-Benz chose to cross-list on the New York Stock Exchange (NYSE) in 1993.

By early 1998, 89% of Daimler shares and Chrysler were still owned domestically. In September of that year the Daimler and Chrysler shareholders approved, nearly unanimously, a pooling-of-interests merger through a share-for-share exchange of a "global registered share" in DaimlerChrysler AG (DCX), which was cross-listed for regular trading on seventeen stock exchanges including the NYSE and the Frankfurt Stock Exchange (FSE). Within six months, American equity ownership of the consolidated firm had shrunk from 44% to 21%. The NYSE's dollar volume of worldwide DCX trading also declined from 28% to 5%, and it remains even lower today.

We examine the causes of the migration of ownership and trading from New York to Frankfurt and find, consistent with Coffee (1999, 2002), that the answers lie within the lack of protection afforded minority shareholders by the corporate governance and disclosure practices[1] of the new entity. Protection of minority shareholder interests, whose numbers were now expanded to include Chrysler shareholders, was significantly weakened with the decision to merge and become a German stock corporation. The release of consolidated accounting statements in March of 1999 revealed the extent, heretofore unknown, of the minority shareholder expropriation involved in the merger. In addition, with German bankers

[1] By "corporate governance standards" we refer to the rules and processes internal to the firm that regulate the rights and responsibilities of the board, managers and other stakeholders. Disclosure practices refer to both the formal and informal reporting and auditing activities that promote the flow of pertinent information about the firm to external constituents.

dominating the DCX Supervisory Board of Directors, domestic investors, particularly concentrated German shareholders and creditors, had greater access to information about and were better able to monitor DCX's activities (Low, 1993; Coval, 1996; and Brennan and Cao, 1997). Thus, the asymmetric information costs for Chrysler assets rose in New York, increasing the asymmetric information component of the DCX spread and the total DCX spread. These higher relative costs of trading in New York resulted in the shifting of trading and price discovery to Germany.

Foucault (1999) and Foucault, Kadan, and Kandel (2001) show that informational uncertainty can induce liquidity traders to price their limit orders less aggressively, resulting in wider observed spreads, higher asymmetric information components of the spread, and reduced depth. Hence, uninformed traders desert the high information cost market. Informed traders then seek to stealth-trade amongst the uninformed traders (Benveniste, Marcus, and Wilhelm, 1992; Barclay and Warner, 1993; and Chakravarty, 2001), so that the domestic market becomes the natural location of price discovery.

In this paper, we confirm these predictions. Our study is based on transaction data for the first six months of trading following the 1998 merger of Daimler-Benz AG and the Chrysler Corporation, which was expected to realize both operating efficiencies and improved access to international capital markets. But post-transaction events increasingly confirmed the expropriation of minority shareholders by controlling shareholders and principal creditors associated with a consolidated German stock corporation as well as the differential information flows associated with a Daimler "takeover."[2]

We document that the trading costs in New York rose substantially following the merger, in part due to the predictably thin trading-related increases in the order processing component of the spread but also due to increases in the asymmetric information component itself. Moreover, while the spreads were rising in New York, they fell in Frankfurt. In addition, we employ common factor components estimation to determine the relative contribution of the FSE and the NYSE to price discovery. Starting from a nearly

[2]This view of the merger is consistent with remarks of DaimlerChrysler CEO Juergen Schrempp to the *Financial Times*, October 30, 2000, pp. 1-2, with a Deutsche Bank Research Department briefing, July 2002, and with the consolidated class action complaint of shareholders in David Rosenberg v. DaimlerChrysler, Federal District Court Delaware, November 2000.

50-50 split at the time of the merger, by April 1999 fully 91% of the permanent information arrivals concerning the consolidated firm were impounded into equilibrium prices first in Frankfurt rather than New York.

2. Daimler's Cross-Listing and Global Registered Share

One cannot examine the significance to minority shareholders of the 1998 DaimlerChrysler merger without first understanding Daimler's decision to become the first German firm to cross-list in the U.S. five years earlier. In 1993, Daimler's controlling interests decided to cross-list on the NYSE using Level II American Depository Receipts (ADRs), apparently having concluded that the benefits to them of cross-listing at that time outweighed the costs. What were these costs and benefits?

The out-of-pocket costs of cross-listing in the U.S. include the accounting, legal, printing and first-time registration fees with the Securities and Exchange Commission (SEC), the listing costs of the stock exchange, and the costs incurred to meet additional disclosure requirements (Radebaugh, Gebhardt, and Gray, 1995). Perhaps as significantly, cross-listing sacrifices some of the private benefits of control by majority investors. However, foreign firms clearly secure benefits from cross-listing in the U.S., particularly those that list on the major exchanges.

Miller (1999) found that firms that cross-list enjoy significantly positive abnormal returns at the cross-listing announcement, and that these returns do not dissipate post-listing. Doidge, Karolyi, and Stulz (2004) report that foreign companies with shares traded on major U.S. exchanges had Tobin's q ratios that were 37% higher than those of non-listing firms, even after controlling for a number of other relevant factors.

Earlier studies attributed the source of the cross-listing benefits to market integration and a lower cost of capital due to global risk-sharing (Karolyi and Stulz, 2002). Doidge, Karolyi, and Stulz's (2004) more recent evidence casts doubt on the market integration explanation and focuses instead on the more stringent U.S. disclosure and corporate governance standards and the enhanced protection of minority

shareholders. Greater minority protection reduces the agency costs of controlling shareholders and thus the value of all publicly traded shares. Significant protection for minority shareholders is contained in the corporate governance standards on board composition and voting rights imposed by the NYSE, but since foreign firms can largely waive the stricter corporate governance standards in cross-listing, the bulk of the benefits must come from the enhanced disclosure itself (Coffee, 2002). In 1993 Daimler-Benz continued its historical corporate governance but opted for an Item 18 Level II ADR on the NYSE which entails the highest of the Level II disclosures standards -- e.g., footnote disclosures that align with U.S. rather than German accounting.

2.1 Anticipated Benefits of 1993 Cross-listing in the U.S.

Higher Disclosure Standards. All foreign firms that cross-list on a U.S. exchange subject themselves to higher disclosure standards. Specifically, those choosing to cross-list with a Level II ADR, as did Daimler, are required to list on a major U.S. stock exchange,[3] file SEC Registration Statement Form F-6, and annually file Form 20-F within six months of the issuer's end of fiscal year. Form 20-F requires a (partial) reconciliation of the cross-listed firm's financial statements to U.S. GAAP accounting principles. It also requires disclosure of non-financial items pertinent to an analyst's projection of future cash flows such as legal challenges, risk factors, competition analyses, related party transactions, material contracts, ownership, officers and directors, and executive compensation (Doidge, Karolyi, and Stulz, 2004).

In addition to these legal disclosure requirements, cross-listed firms also attract the scrutiny of U.S. securities analysts and other members of the investing community, including auditors, rating agencies, regulators, and financial journalists, who generate and distribute information about the firm's cash flows and risks. As a result, cross-listed firms obtain more analyst coverage and have increased earnings forecast accuracy (Lang, Lins, and Miller, 2003). They also enjoy increased market reaction to

[3] Exchange-listed firms and their controlling shareholders are further subject to tender offer rules, "going private" rules, insider trading regulations, and the anti-fraud provisions of U.S. securities laws.

earnings announcements, which suggests that the information content of their earnings announcements is more closely followed (Bailey, Karolyi, and Salva, 2004). Therefore, one can conclude that the legal disclosure requirements and other sources of additional scrutiny by the investing community clearly improve both the quantity and quality of information about the cross-listed issuer available to all shareholders. This enhanced information provides some protection for minority shareholders and offers one explanation for the observed increases in the value of firms that choose to cross-list in the U.S.

Reduction in Agency Cost of Controlling Shareholders and Principal Creditors. The other dominant explanation for the benefits generated by cross-listing centers on the reduction in the agency costs of controlling shareholders (Coffee, 1999, 2002; Doidge, Karolyi, and Stulz, 2004; and Doidge, 2004). When firms are largely controlled by concentrated shareholders, and minority investors are poorly protected by the legal environment, controlling shareholders and principal creditors can easily extract value from the firm at the expense of the minority shareholders. Rather than being forced to disgorge excess cash (Dittmar, Mahrt-Smith and Servaes, 2003), controlling shareholders can divert a disproportionate share of corporate profits before managers distribute the rest as dividends. The diversion can take many forms, including excess payments for contract services, non-arms-length asset transactions (e.g., grants of special drawing rights), and outright theft (La Porta, Lopez-de-Silanes, Shleifer, and Vishny, 2002). In addition, controlling creditors can bias the selection of capital budgeting projects against taking risks that would be in the best interests of stockholders. In a study of several cross-sectional determinants of marginal Tobin's q of 19,010 companies from 61 countries worldwide, Gugler, Mueller and Yurtoglu (2004) find that firms in countries with civil law systems, like Germany, earn returns on investment below their cost of capital. In contrast, those in countries with English common law, like the U.S., earn returns on investment that are at least as large as their costs of capital. These findings are consistent with arguing that cross-listing on a U.S. exchange increases firm value by reducing the agency cost of mechanisms designed to eliminate some of these private benefits of control.

Doidge (2004) uses the dual class shares (with different voting rights) of cross-listed firms to test directly whether the private benefits of control decrease when foreign firms cross-list in the U.S. He finds

that the price of low-voting ("minority") shares increases significantly more on cross-listing than the price of high-voting ("controlling") shares, and concludes that the private benefits of control decrease for firms that cross-list. Further, he finds that these results are even more pronounced for cross-listing firms from countries with poor protection of minority shareholders and weak enforcement mechanisms, like Germany. Doidge, Karolyi, and Stulz (2004) study the same issue and conclude that "U.S. listing reduces the extent to which controlling shareholders can engage in expropriation and thereby increases the firm's ability to take advantage of growth opportunities" (p. 205). Specifically, they find that firms from countries with poorer investor protection, and thus with greater private benefits of control, list only when their growth opportunities are large.

Thus, this agency-cost-reduction benefit to cross-listing is driven by the enhanced value of the publicly traded shares. Controlling shareholders in firms (like Daimler) who contemplate using stock to fund growth opportunities privately benefit from any appreciation in the firm's shares: not only has the value of their personal shareholdings increased, but the increased purchasing power of public shares reduces the dilutive effects of issuing equity to fund growth. Both the greater disclosure and reduction in agency cost explanations are consistent with Daimler using the 1993 cross-listing as a first step in financing stock-swap acquisitions like the 1998 merger with Chrysler.

2.2 The 1998 Merger between Daimler-Benz and Chrysler

The intent of Daimler-Benz and the Chrysler Corporation to merge via a stock swap was announced on May 7, 1998. By using a stock swap instead of cash to consummate the deal, the merger could be recorded using pooling-of-interests accounting thereby generating estimated tax savings of $850 million per year for 40 years.[4] Three years earlier, when Kirk Kerkorian made an unsuccessful $23 billion hostile takeover play for Chrysler, he complained that the company's stock was undervalued due in part to its poor global strategy. Now, Kerkorian voted his 13.7% ownership stake in Chrysler in favor

[4] Kathryn Hanes, "Surviving Flowback," Global Finance. New York: February 1999, vol. 13, Issue 2, p. 46.

of the "merger of equals" and praised Chrysler's "bold initiative" saying it would "create substantial shareholder value by establishing a truly global automotive company."[5]

The May 7 Amended Business Consolidation Agreement announced an intent to incorporate as a German stock company with a total of 18 people on its Management Board, with 10 from Daimler and 8 from Chrysler. The Management Board was to be responsible to the 20-member Supervisory Board which authorizes accounting statements, hires executives, and ratifies all major restructuring decisions including the issuance of capital stock. One of these 20 seats was released to the UAW, nine went to German labor and the remaining 10 were split between Daimler and Chrysler outside directors.

German corporate governance culture is generally marked by high levels of secrecy and non-disclosure (Radebaugh, Gebhardt, and Gray, 1995), and Daimler-Benz's negotiations with Chrysler were no exception. Not until the filing of a joint proxy statement and prospectus with the SEC on August 6 was it announced that the shares of the consolidated German company would be listed directly on the NYSE through a new security called a global registered share (GRS) rather than the previous Level II ADR.[6] The new GRS attracted much financial press and precipitated a major effort by the two companies to avoid the delisting of Chrysler from the S&P 500. But on many other issues, the companies simply remained silent. Specifically, Chrysler officials declined comment on the UAW board seat, and Daimler declined comment on the future compensation of Daimler's German executives.

In 1997, Chrysler CEO Bob Eaton had salary, bonuses and options worth $16 million, eight times the $2 million estimated total compensation of Daimler-Benz CEO Juergen Schrempp. Chrysler's No. 2 executive Bob Lutz had $13 million in total compensation, roughly equal to the $12.3 million disclosed for the entire ten-person senior management team of Daimler-Benz.[7] A May 1, 1998 amendment to the Stock Corporation Act, the Act on Control and Transparency of [German] Enterprises, had lifted prior restrictions against awarding executive stock options contingent on individual company performance.

---

[5] "Chrysler Shareholder Cleans Up," AP. Greensboro News Record. Greensboro, NC: May 8, 1998, p. B6.
[6] "DaimlerChrysler pioneers direct listing for non-US companies" by Nicholas Brumm, Corporate Finance. London: March 1999, Issue 172; p. 45.
[7] *New York Times*, August 13, 1998, p. D4.

Because of the unassailable secrecy attached to Schrempp's total compensation, German shareholders rights activists and trade unionists feared an enormous potential increase in undisclosed executive pay with little or no change in the Daimler-Benz profit-sharing agreement.[8]

Kerkorian and minority shareholders at Chrysler, on the other hand, saw little need for additional performance-based compensation to better align the incentives of the consolidated management team with shareholder interests. Kerkorian had been assured, both in private and in the Amended Business Consolidation Agreement of May 7, that the integration of the two firms would constitute a thorough-going "merger of equals" with Chrysler executives remaining in control of the Chrysler pool of assets.[9] After all, four of the Chrysler senior officers appointed to the new Management Board of the consolidated company had received incentive contracts heavily weighted toward performance-based compensation. The August 6 proxy statements detailed the reloading of 2,267,579 SARs on DaimlerChrysler Ordinary Shares for Bob Eaton, 638,380 for Robert Lutz, 442,685 for Gary Valade, and 407,771 for James Holden.[10] Each dollar that the DCX appreciated above $75.56 earned these former Chrysler executives a dollar in SAR cash exercisable six or twelve months after the consummation date of the merger (in March and September 1999). Despite the additional incentive pay for Eaton, Lutz, Valade, and Holden, DaimlerChrysler remained silent on the issue of German executive compensation.

In theory, stock options or restricted stock grants for the senior German executives could have served as an effective substitute for Germany's weak corporate governance protection of minority shareholder interests. This would have been especially important to Chrysler owners because of the predictably unequal power of Chrysler and Daimler executives on the consolidated management team should the alleged "merger of equals" fail, with German executives tightening their own control. Moreover, Chrysler executives were expected to support almost any transition because of the generous financial package they were due to receive at closing. The May 27, 1998 consolidation agreement had

---

[8] Grasslin (2000), p. 175.
[9] Tracinda Corporate v. DaimlerChrysler AG, Federal District of Delaware, filed November 27, 2000.
[10] Notes to Consolidated Financial Statements, DaimlerChrysler AG, Note 21, Stock-Based Compensation, released March 24, 1999.

revealed that the 30 top Chrysler executives stood to gain $279 million in cash and stock from the early exercise of every management stock option Chrysler ever granted.[11,12]

Apart from these one-time-only payments at the consummation of the merger, a €2 million and a €41.7 million 1998 total compensation expense for the DCX Supervisory and Management Boards, respectively, were disclosed in the 20-F Consolidated Statement released March 24, 1999.[13] Much of this compensation was triggered by pre-merger dividend growth under Daimler-Benz's prior executive contracts and therefore provided no incentive alignment for DCX shareholders going forward. The rest consisted of 22 million new SARs on the appreciation of DaimlerChrysler Ordinary Shares, and two sets of 241,200 convertible bonds granting SARs on DaimlerChrysler Ordinary Shares exercisable six-months and twelve-months from the September 1998 date of issue.[14] This new system of SARs created additional cash compensation for the senior management team at conversion thresholds of €75.78 for the 1997 grants and €106.15 for the 1998 grants. Minority shareholders on both continents would have expected these convertibles and SARs grants to serve the same role in minimizing agency costs as out-of-the-money stock options.

Although the German Commercial Code requires disclosure only of the total compensation paid to the managing board (not broken down by individual manager or type of compensation), the convertible bond instrument would normally have been routinely disclosed as shareholders voted to authorize contingent capital stock. Instead, DaimlerChrysler chose to issue SARs rather than stock conversion privileges. Since SARs are settled in cash rather than stock, shareholder approval was not necessary, and no disclosure of these grants was made prior to the release of the Annual Report and 20-F in March 1999.

Thus, at a time when DaimlerChrysler compensation was changing in management's favor,

---

[11] For example, CEO Bob Eaton stood to gain $69 million, Robert Lutz $27 million, Thomas Stallkamp $25 million, Gary Valade $23 million, and Bob Pawley $22 million. These are Vlasic and Stertz's (2000, p. 267) calculations based on the May 27, 1998 Amended Business Consolidation Agreement.

[12] Notes to Consolidated Financial Statements, Note 21, Stock-Based Compensation, released March 24, 1999 recognized a $279 million expense.

[13] Notes to Consolidated Financial Statements, Note 21, Stock-Based Compensation, released March 24, 1999.

[14] SEC Form 20-F, DaimlerChrysler AG, File No. 1-12356, Item 11, Compensation of Directors and Officers, released March 24 and filed March 31, 1999.

minority shareholders were left in the dark to wonder whether their shareholder protections and disclosure rights were in great jeopardy (Gordon, 2000). The revelations in the 20-F six months later resolved any remaining uncertainty as to whether minority institutional investors had equal access to material information on Chrysler's cash flows, particularly those relating to executive compensation. The clear implication -- the hard-learned lesson -- was that they did not. Minority expropriation by controlling shareholders and principal creditors was proceeding unheeded.[15]

A timeline of subsequent events is presented in Figure 1. On September 18, 1998, shareholders on both continents approved the pure stock swap deal creating DaimlerChrysler AG. Because the consolidated company was incorporated as a German legal entity, Chrysler was deleted from the Standard & Poor's 500 Index October 12th. On November 17, 1998, global registered shares in DCX began trading at $82 on seventeen exchanges throughout the world. The DCX stock price tested new highs at $99 in December and $108 in January before beginning a sustained decline to $89 in March, $70 in September 1999, and $53 or lower since March 2000 (see Figure 2). A low of $70 for DCX in September 1999 implied that a share of Chrysler stock was worth $43.65 ($70 x .6235) one year after the merger, almost identical to the $44 at the April 14 merger agreement lock-in date seventeen months earlier. Over the intervening period, the 28% merger premium (to $57 from $44) that CEO Bob Eaton had negotiated for Chrysler stockholders had completely eroded away.

---

[15]-SARs settled in cash, during a pooling-of-interests merger, provided an excellent opportunity to hide the executive compensation grants. The SARs and DCX convertible bonds represented a new liability on the balance sheet for the consolidated company which necessitated the creation of a contra equity account on the asset side of the balance sheet. Pooling-of-interests mergers are filled with plug numbers, i.e., shareholder equity is a plug number. It was therefore easy to hide the extent to which the issue of the SARs and convertibles to the German executives was actually an expropriation of minority shareholder interests from the Chrysler pool of assets. GAAP-compliant disclosure of the contra equity account was not mandatory until the Consolidated Statement appended to the 1998 DaimlerChrysler Annual Report was released March 24, 1999, two months late and six months after the merger was approved. As a contra equity adjustment to Chrysler cash, this expropriation from minority shareholders would suggest that the merger itself continued a governance structure where majority German shareholders and principal creditors could enjoy significant private benefits of control.

2.3 Trends in DaimlerChrysler Trading

On February 23, 1999 the complete 1998 financial results of the combined company were publicized, and on March 24th a consolidated 1998 annual report (10K) and the accompanying 20F reconciliation of foreign cash flows were released. Through March, Chrysler maintained an 18% market share in U.S. passenger cars and light trucks, two share points *higher* than its record sales in 1998. Nevertheless, DCX ownership began to shift in late February, and the stock price eroded to $89 in April, despite record Chrysler sales and profits. As a result of a surge of DCX selling by U.S. mutual funds, U.S. ownership dropped abruptly in April 1999 to 21% from 44% the previous November.

Also, over the November 1998 to April 1999 period, the trading volume of DCX shares on the NYSE declined precipitously. Combining the dollar-equivalent volume of trading in both firms at the merger exchange ratio of 0.6235 DCX share per Chrysler share and 1.005 DCX share per Daimler-Benz share, the NYSE executed 26.7% of the trading volume in the two firms for the six months prior to November 17, 1998. And this figure was remarkably stable between the merger announcement in May and the first day of trading in DCX in November, varying from a high of 28.7% to a low of 24% (Karolyi, 2003). After the inception of DCX trading, however, the NYSE trading of the combined firm fell off to 17% in late December 1998, 14% in late January 1999, and 9.7% in late February 1999. By the last week of March, as the complete consolidated financial results for 1998 were being released, NYSE trading volume was only 8%, and in late April just 5%, one-fifth of its pre-merger level (Karolyi, 2003). In 2001, this figure stood under 3%.[16]

3. Differential Information Flows

In analyzing the DaimlerChrysler governance and disclosure choices, it is useful to distinguish two distinct levels of information flow associated with a publicly traded firm. One is the information generated by an ex-post examination by the Management and Supervisory Boards and controlling investors of managerial decisions as they affected the variance of asset cash flows. The other is the

[16] "What in the World? Global Shares May Leave Obscurity," *Wall Street Journal*, August 20, 2001, p. C1.

information generated by the ex-ante control exerted by the Management and Supervisory Boards and controlling investors over the decision processes that create the cash flows, including approving capital investment decisions and executive compensation packages.

Disclosure requirements, while having everything to do with the *revelation* of pertinent information actually have very little to do with the *creation* of asset cash flows and risks. Disclosure requirements must focus on the types of information about a company's performance that can be monitored and verified, i.e., the variance of asset cash flows that result from corporate decisions. It is much more difficult to mandate the disclosure of behind-the-scenes negotiations between controlling parties about the types of asset, capital budgeting, compensation, and financing strategies their company may employ. And in countries where the board members, controlling shareholders and principal creditors can enjoy the private benefits of control, even the most stringent disclosure requirements, though *disclosing* the expropriation of value from minority shareholders, do little to prevent it.

We posit that such was the case with DaimlerChrysler. U.S. institutional ownership in Chrysler was largely replaced by European banks that not only directly monitor the working capital financing of DCX, but also may sit on its Management Board and place staff assistants throughout the senior DCX executive offices. In addition, European banks that are major stockholders and/or creditors may also sit on the Aufsichtsrat Supervisory Board of Directors that authorizes all corporate restructuring deals and must approve the annual report and other accounting statements. In a nominal sense, this bank access actually exceeds that of the senior DCX executives themselves because the management team of a German corporation is not allowed to serve on the Aufsichtsrat. Such extraordinary differences in access to information suggest a significant information advantage for European banks and greater informational uncertainty for American investors, despite the transparency of accounting statements mandated for a Level II ADR and GRS by the NYSE.

Specifically, the March 24, 1999 release of DaimlerChrysler's 20-F reconciling German with U.S. GAAP-compliant accounting did provide greater transparency. Any use of Chrysler assets to offset the new incentive pay for German executives, any dilutive effects of the €22 million in new SARs

granted at the merger with six-month and one-year exercise dates,[17] or any arcane twists and turns in loss reserves accounting should not have prevented equity analysts on both sides of the Atlantic from reaching similar conclusions about DCX's valuation. While the two-month delay of these consolidated accounting statements could in and of itself explain heavy selling pressure from all DCX investor groups, it cannot explain why trading volume and equity ownership shifted from the U.S. to Europe in the winter of 1999.

3.2 Development of Hypotheses

Instead, we argue that with the release of DaimlerChrysler's 20-F, U.S. institutional investors realized that their heretofore unencumbered access to speedy and accurate information about Chrysler assets had deteriorated markedly. The newly subsumed Chrysler assets were now under the control of a German stock corporation with concentrated control rights, markedly diminished minority shareholder protection (Franks and Mayer, 2001), and differential access for European institutional investors. As a result, the mean level of information about the newly merged assets would be lower and the variance of information would be higher among U.S. institutional traders than among European institutional traders. Real-time information asymmetries are especially relevant to arbitrage trading of a global registered share because of the absence of time-to-conversion delays typically associated with ADRs. Therefore, we investigate empirically whether differential information costs explain the migration of trading. Specifically, we test the following hypotheses:

$H1a_0$: Following the merger, asymmetric information costs increase in New York.

$H1b_0$: Following the merger, asymmetric information costs decline in Germany.

With little or no change expected in order processing costs, this difference in the asymmetric information component of the spread leads to increased relative trading costs in New York. Therefore, we test the hypotheses:

$H2a_0$: Following the merger, relative trading costs increase in New York.

[17] Notes to Consolidated Financial Statements, DaimlerChrysler AG, Note 21, Stock-Based Compensation, released March 24, 1999.

$H2b_0$: Following the merger, relative trading costs decline in Germany.

Of course, the two primary markets for DCX's shares have significantly different market architecture. The NYSE operates a continuous market with a batch opening and subsequent liquidity provided by the specialist dealer, the public limit order book, and the crowd. In contrast, the FSE operates a screen-based limit order book trading system and floor-based market through brokers. These differing market mechanisms may well generate a different level of trading costs in the two trading venues. Liquidity traders would be expected to cluster where the trading costs are lowest (Chowdry and Nanda, 1991), and informed stealth traders would be expected to follow.

To the extent U.S. institutions trade in New York and European institutions with differential access to Daimler boardrooms trade in Frankfurt, overall trading costs in Frankfurt should fall below those in New York post-merger because of the reduced asymmetry of substantive information between European institutional buyers and sellers. Although the 1993 cross-listing of a Level II ADR in the U.S. was pivotal (for reasons explained in section 2 above) to the acceptance by Chrysler shareholders of the 1998 DCX global registered share and stock-for-stock merger at a ratio of 0.6235 to 1, Coffee (2002) argues that continued U.S. trading of DCX beyond the time of the merger was not. That is, given the ease and reliability of DCX's global registered share trading facility, little prevented uninformed trading and stealthy informed trading from flowing back to German capital markets when and if lower trading costs presented themselves. Hence, if hypotheses $H1_0$ and $H2_0$ are confirmed, we will also test a price discovery hypothesis from market microstructure:

$H3_0$: Information signals that get impounded into permanent price changes for the post-merger DCX firm will appear first in the Frankfurt market.

4. Data

We obtain German trading data from the FSE and NYSE trading data from the NYSE's TAQ database. The merger of Daimler-Benz AG and Chrysler Corporation was consummated with an exchange of stock in late October 1998. Trading of global registered shares began November 17, 1998. We have the price, time, and size of every GRS trade from the first day of trading through May 1999 for

both exchanges. The FSE data contain many order characteristics of the electronic order book that are explained in detail in the *Xetra: Market Model Release* dated April 17, 1998, available from Gruppe Deutche Borse. The NYSE data also include the price, time, and quantity of every quote that betters an existing quote. Because quotes may be recorded ahead of trades (Lee and Ready, 1991) we adjust the NYSE quote times by five seconds. We use all trades except the first trade of the day. We convert DEM and EUR prices to USD prices using trade-to-trade foreign exchange data from Olsen Associates.

We use all of the data for our analysis except when we investigate which market is contributing to price discovery. That analysis uses only data for the period (typically two hours) during which trading overlaps on the NYSE and FSE each day. To facilitate comparison we convert all Frankfurt times to New York time, taking into account differences in the implementation of daylight savings time.

4.1 Empirical model of trading costs and components of the spread

In Table 1 we provide three measures of the bid-ask spread—one involving only quotes, one involving both trade prices and quotes, and one involving only trade prices. We present all three measures for the NYSE, but since we do not have quote data for the FSE, we present the measure involving only trades for that exchange. The quoted spread is the best ask minus the best bid. The effective spread is twice the absolute difference between the trade price and the most recent quote midpoint (Bessembinder and Kaufman, 1997). The implicit spread is calculated as $2\sqrt{-c}$, where c is the covariance of returns, following Roll (1984).[18]

In addition to examining aggregate spreads, we also investigate the components of the spread using the model of Lin, Sanger, and Booth (1995). Adverse selection costs and order processing costs are estimated as percentages of the effective spread. The adverse selection component of the spread shows

[18] Roll's procedure is based on the insight that if the ask and bid are stationary and if buys and sells are equally likely, bid-ask bounce will result in a negative covariance of returns. Implementation of the procedure is sometimes hindered by the fact that many empirically-estimated return covariances are positive. For the return series examined here, however, the first-order return covariances are negative for every month for both the NYSE and FSE.

whether liquidity providers in both markets face the same risk of trading with asymmetrically informed investors.

Trade size categories are created to detect the effect of individual versus institutional trades on the adverse selection component of the bid-ask spread. Following Lin, Sanger, and Booth (1995), all trades are divided into five size-percentile categories from lowest trade size to highest trade size: less than 25 percent, 25 to <50 percent, 50 to <75 percent, 75 to <90 percent, and 90 percent and over. This method produces different actual trade size cutoffs for the same categories for each month depending on the liquidity in various trade sizes.

For each of the six months after the merger for each size category (and for the entire sample), the bid-ask spread's adverse-selection cost is estimated as,

$$(1) \qquad \Delta Q_{t+1} = \alpha + \lambda Z_t + e^{q}_{t+1}$$

where $\Delta Q_{t+1} = Q_{t+1} - Q_t$, Q_t is the log of the quote midpoint at time t, Z_t equals $P_t - Q_t$, P_t is the log of the trade price at time t and e_{t+1} is the error term. The adverse-selection component is represented by the parameter, λ. The order processing cost is estimated as

$$(2) \qquad \Delta P_{t+1} = \alpha + \gamma Z_t + e^{p}_{t+1}$$

where $\Delta P_{t+1} = P_{t+1} - P_t$. The order processing component is represented by the parameter γ. Because of the obvious cross-equation correlation of the error terms in (1) and (2), seemingly unrelated regression procedures are appropriate.

4.2 Error correction modeling, price discovery, estimation and testing of common factor weights

In addition to market metrics, we employ error correction/common factor methods to estimate the contribution of each market to price discovery using the approach of Gonzalo and Granger (1995). The specification for these common factor models is provided in the Appendix.

5. Empirical results

Table 1 shows that trading costs increased substantially in New York following the release of the complete financial results for 1998 on February 23 and the consolidated annual report (10K) on March 24, 1999, consistent with hypothesis $H2a_0$. For the NYSE, the quoted spread increased by more than 30% from an average of 18.9 (= (18.8 + 19.0)/2) cents in November/December 1998 to 24.2 cents in February/March 1999.[19] The implicit and effective NYSE spreads also peaked in late February and March (at 10.2 cents and 10.9 cents, respectively) concurrent with the company's public announcement and subsequent release of its annual report. In the first two months of trading, NYSE implicit and effective spreads had been substantially lower at 8.5 cents and 8.8 cents, respectively. In contrast to these stark increases in trading costs over the first five months in New York, implicit spreads in Frankfurt were nearly constant at 6.7 cents from November to March, before declining to 5.0 cents and 4.8 cents in April and May, consistent with hypothesis $H2b_0$.

Wilcoxon rank sum tests of the mean spreads each day during the first six months of trading, especially in the period after the February 23rd announcement relative to the four-month period before, confirm that spreads rose in New York and declined in Frankfurt. First, we rank trades according to the number of shares per trade (trade size) and perform a t-test (using a confidence level of 0.01) on the mean rank for each day in the 1998 versus 1999 data. We replicate the test for the period before and after February 23, 1999. For Panel A (New York results), we find that trade size is significantly lower (t = 20.1) in 1999 compared to 1998. We also find that the trade size was significantly lower (t = 19.4) in the period after February 23rd. Using an identical procedure for daily spreads, the quoted spread in New York is significantly higher in 1999 than in 1998 (t = 83.0) and significantly higher in the after-period than in the before-period (t = 52.6). The effective spread in New York is also significantly higher in 1999 than in 1998 (t = 33.1) and in the after-period than in the before-period (t =21.6). Finally, the implicit spread in

[19] Average trade size also declined in New York from 1,906 in November/December to only 1,140 in February/March.

New York is significantly higher in 1999 than in 1998 (t = 3.84) and in the after-period than in the before-period (t = 2.24).

For Panel B (Frankfurt results), the implicit spread in Frankfurt is significantly lower in 1999 than in 1998 (t = 3.84) and in the after-period than in the before-period (t =2.89). This result confirms hypothesis $H2b_0$. Clearly, it would be desirable to confirm that quoted and effective spreads also declined in Frankfurt, but we are unable to obtain the Xetra quote data required for this analysis. Nevertheless, some market quality assessments that bear on the migration of trading from New York to Frankfurt are indicated by trade size volatility and depth on Xetra.

DCX trade size became less volatile and the depth became greater in Frankfurt over the period. The standard deviation of the Xetra trade size declined from 2,746 in November to 1,736 in February before multimillion share orders spiked this metric in March of 1999. By May of that year, trade size volatility on the FSE was 2/3rds (1,841) of what it had been in November. In contrast, NYSE trade size volatility in May remained double its earlier level (3,462), and depth in New York was only 1,217 shares relative to Frankfurt's 1,731 shares on average.[20] In general, DCX liquidity improved in Frankfurt relative to New York over the period.

In Table 2 we report a significant increase in the adverse selection component of the NYSE spread, consistent with hypothesis $H1a_0$, as U.S. investors' fears about an informational disadvantage relative to controlling German shareholders and Daimler's principal creditors were reinforced by the revelations in the consolidated accounting releases. In the aggregate NYSE data in the last row of Panel A of Table 2, the adverse selection component of the effective spread averaged 5.0% in November, December and January, prior to the news release on the consolidated accounting results. After the news release, the NYSE adverse selection component increased by almost 40% to average 7% in February through April (6.2% in February, 7.4% in March and 6.9% in April). If we include May's figure (11.7%), the increase was even higher – i.e., a 60% increase over the months preceding the news release.

[20] We recognize in the discussion section that some of this additional depth in Frankfurt reflects the contemporaneous development of the more efficient Xetra electronic order-driven system on the FSE.

Table 2 also reports our findings with respect to the NYSE adverse selection component by trade size class. Since informed traders are often thought to congregate in mid-size or smaller size classes, the 76-90th and 91st-100th percentile size classes isolate the hypothesis that higher information cost for U.S. institutional investors about the consolidated DCX raised trading costs on these NYSE liquidity traders. Foucault (1999) shows that an increase in informational uncertainty increases picking off risk for liquidity traders, causing less aggressive pricing of limit orders, resulting in larger asymmetric information components and wider spreads. From 3.7% and 4.7% of the effective spread in November and December, the adverse selection component in the 76-90th size class rises fourfold to 13.7% in January, 13.2% in March, 15.1% in April, and 17.9% in May.[21] In the largest trade size class, after a 48.7% adverse selection component in the days immediately following the merger, the adverse selection component averages approximately 20% for every month thereafter except for a 50.6% spike in March. We interpret both of these larger and very large size-class results as strong evidence consistent with hypotheses $H1a_0$ and $H1b_0$ of differential access to information following the late February announcement and March release of the first consolidated annual report.

Order processing costs are also reported in Panel B of Table 2. They are generally small (except where substantial order imbalances exist) varying from 1 to nearly 5% percent of the effective spread in the aggregate data reported in the bottom row. When two seller-initiated trades of one million shares were executed in New York in April, order processing costs skyrocketed to 20% of the effective spread. Interestingly, although both trades executed in the upstairs market, clearing the book downstairs substantially reduced liquidity and raised the order processing cost in the medium-sized trades (see 25-50th percentile trade size results in Panel B of Table 2). Because these two difficult trades in April were such outliers, the descriptive statistics reported for April in Table 1 were adjusted to exclude these events. Our evidence about trading costs in New York rising after the February 23rd announcement is even stronger if these two million share trades are included in the analysis.

[21] February shows a spectacular spike of the adverse selection component to 43.8%, which is consistent with the sharp drop to 11,346 in the number of New York trades reported in Table 1 for February relative to 18,569 in January and 18,069 in March.

As the cost of trading DCX on the NYSE rose, the dollar volume of trading in New York declined substantially. As displayed in Figure 1, the 28% NYSE dollar volume of DCX worldwide trading in November shrank to less than 8% in March and only 5% in April. In contrast, on the FSE the dollar-equivalent volume of DCX worldwide trading rose from 69% in November to 92% in April.

Consistent with hypothesis $H3_0$, the price discovery results dovetail with our findings on trading costs. As asymmetric information trading costs rose after late February 1999, not only the volume but the trades that led to new permanent price moves shifted from approximately 50% in New York and Frankfurt to 90% in Frankfurt. Table 3 supports the maintained hypothesis of a comparable first-order of integration for both series. In addition, the residuals of these augmented Dickey-Fuller regressions are indistinguishable from stationary white noise error terms. At an optimal lag length of two synchronous trades, the Johansen test statistics for first-order cointegration C(1), reported in Table 4, are significant at 95% in January and February and at 99% in March-May 1999. Finding cointegraton between these two GRS price series for DCX trading in Frankfurt and in New York, there is one common factor corresponding to the common stochastic trend $\sum_{t=1}^{T} w_t$ in our Appendix model structure.

The estimated common factor weights in the last two columns of Table 4 show that each market contributed roughly equally to the common factor initially, with Frankfurt trades revealing 53.7% of the new permanent price trends in January and 58.7% in February 1999. New York trades revealed 46.3% and 41.3%, respectively, in these two months. By March, however, the location of price discovery had shifted radically: 89.5% of the price discovery occurred in Frankfurt in March and 90.8% in April.[22] The error correction results in Table 5 confirm these findings. New York price changes (in the right-hand column of Table 5) respond in a statistically significant magnitude and with the expected sign to price

[22]Focusing on FX adjustments in the DCX stock trading a year after the merger -- i.e., from August through October 1999 -- Grammig, Melvin, and Schlag (2001) confirm this finding of only a 9% information share for the NYSE prices in their study of price discovery for DCX (and two other German cross-listed stocks). Grammig, Melvin and Schlag (2004) show that the 91% home country (Germany) information share is biased upwards by ignoring foreign exchange (FX) innovations but that the true German information share is 90% -- i.e., a negligible 1% bias is attributable to FX innovations.

disparity with Frankfurt as reflected by the error correction term. In particular, in this VECM specification the error correction term $z_{t-1} = P_f - P_{ny}$ is positive and significant in the ΔP_{ny} equation in the right-hand column, as expected, but is insignificant in the ΔP_f Frankfurt equation on the left.

Once the internal information about Chrysler arising from the direct monitoring by German banks of DCX consolidated cash flows became less transparent to U.S. analysts and typical NYSE institutional traders, New York prices began to adjust themselves consistently to any disparity from Frankfurt prices to maintain cointegration equilibrium. In contrast, Frankfurt prices seldom adjusted to randomly-induced disparity from New York prices. This one-way price adjustment and price discovery resulted from asymmetrically informed traders executing in the exchange where trading costs were lower (the FSE). Grammig, Melvin and Schlag (2004) find offshore trading costs, measured by relative spreads, are by far the larger of the two cross-sectional determinants (namely, spread and turnover) of home market price discovery. The Frankfurt Stock Exchange came to dominate DCX price discovery because it was favored by liquidity traders who wished to execute with European institutional buyers and sellers that exhibited the least informational uncertainty. In short, lower informational uncertainty generates lower total trading costs which attract uninformed and hence informed stealth traders. Thus, our results suggest a conjecture for further research that a rational motivation for home bias in executing cross-listed securities is increased asymmetric information offshore.[23]

6. Discussion of results

The basic story supported by our findings is really quite simple. When DCX incorporated, the consolidated firm adopted German monitoring and control practices. German control rights diminish the protection of minority stockholders relative to U.S. control rights, and foreign shareholders typically find themselves among this minority group. Access and control created an informational advantage for large German institutional owners relative to minority foreign owners, despite the transparency afforded by the

[23] Clearly, what matters beyond simply the components of the spread is total transaction costs including withholding taxes, export restraints, legal and language expenses, and hedging costs.

global registered share. Recognizing said asymmetries, New York limit order submitters and the NYSE specialist priced less aggressively, thereby raising the adverse selection component of the New York spread. Volume in New York declined and overall trading costs rose, driving uninformed trades in DCX to a cheaper trading venue in Frankfurt. An ever-greater proportion of the information-based trading, therefore, followed the available liquidity to the German market.

The evidence in Tables 1 - 5 is overwhelming that the adverse selection component of the spread and trading costs more generally rose in New York relative to Frankfurt and that, contemporaneously, price discovery migrated from New York to Frankfurt. Implicit, effective and quoted spreads rose in New York beginning as early as January 1999. Significant increases in the adverse selection component of the New York spread occurred somewhat later, depending on the trade size category. Informational asymmetries in the 76th to 90th percentile trade sizes spiked in February, and informational asymmetries in the largest trade sizes (above 90th percentile) spiked in March. The fact that these effects show up over a two-and-a half-month period is consistent with our contention that the informational advantage arose from differential control rights and differential access to internal company accounting data rather than from a time-specific information event.

The role of German control rights and the exact timing of an asymmetric information advantage for German institutional investors are best understood within the context of Daimler's equity capital raising over the decade of the 1990s. In 1993, Daimler-Benz employed the strict disclosure requirements of a Level II ADR on the NYSE to ameliorate the effects of a weak corporate governance structure on the Daimler stock price. Growth through acquisitions was crucial to surviving the consolidation sweeping across the global auto industry. Finding that poorly protected minority investors were initially reassured by the disclosure requirements of their cross-listing, Daimler orchestrated a pure stock-swap with Chrysler that allowed pooling-of-interests merger accounting with all its numerous plug numbers. Adopting a stock appreciation rights system settled in cash to incent the consolidated management team also allowed the private benefits of controlling shareholders and principal creditors to continue.

When the full extent of the on-going minority expropriation by controlling stockholders and principal creditors was revealed six months after the merger by the 20-F consolidation statement reconciling with GAAP, U.S. institutional investors perceived a substantial informational disadvantage relative to their European counterparts on the various Boards of DaimlerChrysler and promptly sold their positions in DCX. As uninformed traders, they sought a venue with the lowest total trading costs. That venue was the FSE. Spreads were lower than in New York because of the reduced informational uncertainty of the large DCX shareholders and principal creditors supplying liquidity on the FSE. Information-based trading then followed the available liquidity to Germany.

Competing Alternative Hypotheses.

Note that there are two competing alternative hypotheses that we cannot fully distinguish with our empirical findings. A thorough-going comparative institutional analysis of trading in New York and Frankfurt is beyond the scope of the present paper. Nevertheless, we recognize that perhaps trading costs fell and liquidity migrated to Xetra, not because of the potential for expropriation of minority investors imbedded in the German corporate governance code and the related informational disadvantage of U.S. institutional investors, but because Xetra is a superior trading system. Xetra's market design of screen-based trading with an electronic limit order book that preserves anonymity for both demanders and suppliers of liquidity has attracted much of the order flow away from the Deutsche Bourse floor trading. However, Xetra has not dominated New York or other international exchanges in numerous other cross-listings, so the trading mechanisms in Xetra are an unlikely explanation for the migration of trading from New York to Frankfurt.

Another alternative explanation for the 44% to 21% decline in U.S. equity ownership of DCX is that U.S. mutual funds disinvested because of Chrysler's deletion from the S&P 500 index. Despite the path-breaking transparency and transferability of their global registered shares, DaimlerChrysler incorporation in Germany made the consolidated firm technically ineligible for inclusion in the S&P index. Daimler-Benz and Chrysler mounted a spirited campaign to appeal the scheduled deletion at a

special S&P hearing in Brussels on September 3, 1998 but all to no avail. On October 1st, Standard and Poor's announced that Chrysler would be replaced (on October 12) by Safeway in the S&P 500 index.

American index funds do tend to hold large cap stocks, especially S&P 500 stocks. By 1999, index funds accounted for over 10% of total U.S. equity fund assets, and this figure has risen very sharply from only 2% in 1990. Moreover, during 1999 U.S. index funds attracted 30% of all net new cash flow to U.S. mutual funds.[24] Consequently, the October index deletion of Chrysler did trigger substantial selling pressure from U.S. fund managers tracking the S&P 500. Despite this S&P 500 deletion, however, other fund managers and individual investors generated sufficient counterparty order flow to maintain market capitalization in the early months following the merger. Indeed, Figure 2 shows that DCX tested new highs for several months after the index deletion (i.e., during November and December 1998 and again in January 1999). Moreover, DCX's SEC 13F quarterly filings document that U.S. institutional ownership peaked three months after the deletion at 67.7 million shares in the last quarter of 1998 and remained at 54.5 million shares as late as the first quarter of 1999. In the timeline of Figure 1 we therefore convey that the U.S. institutional sell-off really occurred in March and April 1999-- i.e., six and seven months after the S&P 500 deletion. Only then did U.S. ownership of DCX abruptly decline to 21%.

7. Conclusion

Microstructure metrics and VECM research techniques help explain investors' execution choices in response to international cross-listings. Better and more up-to-date information leads to less adverse selection in the liquidity trading of German companies on the FSE compared to the NYSE. As a consequence, trading costs declined in Frankfurt relative to New York after the consolidation of Chrysler and Daimler-Benz. Greater informational uncertainty in New York raised the asymmetric information component of the NYSE spread. Price discovery locates where trading costs of liquidity traders are lowest so that offshore order flow implies offshore price discovery.

[24] Reid and Millar (2000) Mutual fund assets and flows in 1999, Perspective, Investment Company Institute, 2(2), February.

Weaker corporate governance in German stock corporations accentuates the informational disadvantage perceived by minority shareholders relative to the direct access of controlling shareholders and principal creditors. Because of weaker board composition standards, less incentive-based executive compensation, and fewer voting rights, U.S institutional investors feared expropriation of their minority shareholder interests in the consolidated DCX. When the 20-F reconciliation statement of consolidated operations revealed the full extent of the executive compensation arrangements that the merger mechanisms had been intentionally designed to hide, fears of continuing minority expropriation led to a further concentration of ownership.

Cross-listing disclosure requirements, though they provide measurable reductions in asymmetric information, are an insufficient substitute for strong corporate governance to protect minority shareholders. Strict disclosure complements strong corporate governance, and both may be required to create environments in which firms can raise capital and fund growth opportunities most efficiently.

Our study suggests a number of avenues for further research. The effect of control rights on trading costs is a largely unexplored topic for microstructure research. Yet, we have shown microstructure metrics can be useful in detecting and measuring the extent and value of control rights. Control of some firms is limited to a single country due to various governmental restrictions (e.g., Japan) while control of other firms may be traded globally. Is the value of corporate control and of the firm greater if control can be traded globally? What is the value to the German economy and to German financial markets of being the principal channel of liquidity and price discovery in DCX?

References

Bailey, W. B., Karolyi, G. A., Salva, C., 2004. The Economic Consequences of Increased Disclosure: Evidence from International Cross-Listings, Dice Center Working Paper No. 2002-4.

Baillie, R.T., Booth, G. G., Tse, Y., Zabotina, T., 2002. Price discovery and common factor models, Journal of Financial Markets 5, 309-322.

Barclay, M., Warner, J., (1993). Stealth Trading and volatility: Which trades move prices? Journal of Financial Economics 34, 281-305.

Benveniste, L., Marcus, A., Wilhelm, W., 1992. What's special about the specialist?, Journal of Financial Economics 32, 61-86.

Bessembinder, H., Kaufman, H. M., 1997. A cross-exchange comparison of execution costs and information flow for NYSE-listed stocks, Journal of Financial Economics 46, 293-319.

Brennan, M. J., Cao, H. H., 1997. International portfolio investment flows, Journal of Finance 52, 1855-1880.

Chakravarty, S. (2001). Stealth trading: Which traders' trades move stock prices?, Journal of Financial Economics 61, 289-307.

Chowdry, B., Nanda, V., 1991. Multimarket trading and market liquidity, Review of Financial Studies 4, 623-656.

Coffee, J. C., 1999. The future as history: The prospects for global convergence in corporate governance and its implications, Northwestern Law Review 93, 641.

Coffee, J. C., 2002. Racing towards the top: the impact of cross-listings and stock market competition on international corporate governance, Columbia Law Review 102, 1757-1831.

Coval, J. D., 1996. International capital flows when investors have local information, Working paper, University of Michigan.

de Jong, F., 2002. Measures of the contribution to price discovery: a comparison, Journal of Financial Markets 5, 323-327.

Dittmar, A., Mahrt-Smith, J., Servaes, H., 2003. International Corporate Governance and Corporate Cash Holdings, Journal of Financial and Quantitative Analysis 38, 111-133.a

Doidge, C., 2004. U.S. Cross-listings and the Private Benefits of Control: Evidence from Dual Class Firms, Journal of Financial Economics 72, 519-553.

Doidge, C., Karolyi, G. A., Stulz, R., 2004. Why are foreign firms listed in the U.S. worth more?, Journal of Financial Economics 71, 205-238.

Engle, R., Granger, C., 1987. Co-integration and error correction: representation, estimation, and testing, Econometrica 55, 251-276.

Foucault, T., 1999. Order flow composition and trading costs in a dynamic limit order environment, Journal of Financial Markets 2, 99-134.

Foucault, T., Kadan, O., Kandel E., 2001. Limit order book as a market for liquidity, Working paper, HEC School of Management.

Franks, J., Mayer, C., 2001. Ownership and control of German corporations, Review of Financial Studies 14, 943-977.

Gonzalo, J., Granger, C., 1995. Estimation of common long-memory components in cointegrated systems, Journal of Business and Economic Statistics 13, 1-19.

Gordon, J.C., 2000. Pathways to Corporate Convergence? Two Steps on the Road to Shareholder Capitalism in Germany: Deutsche Telekom and DaimlerChrysler, Working paper # 161, Columbia Law School, Center for Law and Economic Studies.

Grammig, J., Melvin, M., Schlag, C., 2001. Internationally Cross-Listed Stock Prices during Overlapping Trading Hours: Price Discovery and Exchange Rate Effects, Journal of Empirical Finance.

Grammig, J., Melvin, M., Schlag, C., 2004. The Role of U.S. Trading in Pricing Internationally Cross-Listed Stocks, Paper No. 3267, European Finance Association 2004 Maastricht Meetings

Grasslin, J., 2000. Juergen Schrempp and the Making of an Auto Dynasty. McGraw-Hill: New York.

Gugler, K., Mueller, D., Yurtoglu, B., 2004. Corporate Governance and the Returns on Investment, Journal of Law and Economics 47, 589-633.

Harris, F. DeB., McInish, T. A., Shoesmith, G., Wood, R. A., 1995. Cointegration, error correction and price discovery on informationally-linked security markets, Journal of Financial and Quantitative Analysis 30, 563-579.

Harris, F. DeB., McInish, T. H., Wood, R. A., 2002a. Security price adjustment across exchanges: an investigation of common factor components for Dow stocks, Journal of Financial Markets 5, 277-309.

Harris, F. DeB., McInish, T. H., Wood, R. A., 2002b. Common factor components versus information shares: a reply, Journal of Financial Markets 5, 341-348.

Hasbrouck, J., 1995. One security, many markets: determining the contributions to price discovery, Journal of Finance 50, 1175-1201.

Hasbrouck, J., 2002. Stalking the "efficient price" in market microstructure specifications: an overview, Journal of Financial Markets 5, 329-340.

Huang, R. D., 2002. The quality of ECN and Nasdaq market maker quotes, Journal of Finance 57, 1285-1319.

Karolyi, G. A., 2003. DaimlerChrysler AG: the first truly global share, Journal of Corporate Finance 9, 409-430.

Karolyi, G. A., Stulz, R. M., 2002. Are financial assets priced locally or globally? In: Constantinides, G., Harris, M., Stulz, R. M., (Eds.), The Handbook of the Economics of Finance. North-Holland Elsevier, New York, NY.

Lang, M. H., Lins, K. V., Miller, D. P., 2003. ADRs, Analysts, and Accuracy: Does Cross Listing in the United States Improve a Firm's Information Environment and Increase Market Value?, Journal of Accounting Research 41, 317-346.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., 1999. Corporate Ownership Around the World, Journal of Finance 56, 471-517.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 2002. Investor Protection and Corporate Valuation, Journal of Finance 57, 1147-1170.

Lee, C., Ready, M., 1991. Inferring trade direction using intraday data, Journal of Finance, 46, 733-746.

Liberman, O., Ben-Zion, U., Hauser, S., 1999. A characterization of the price behavior of international dual stocks: an error correction approach, Journal of International Money and Finance 18, 289-304.

Lin, J. C., Sanger, G., Booth, G. G., 1995. Trade size and components of the bid-ask spread, Review of Financial Studies 8, 1153-1183.

Low, A., 1993. Essays on asymmetric information in international finance, unpublished dissertation, The Anderson School at UCLA.

Miller, D. P., 1999. The market reaction to international cross-listings: evidence from depository receipts, Journal of Financial Economics 51, 103-123.

Reid, B., Millar, K., 2000, Mutual fund assets and flows in 1999, Perspective, Investment Company Institute, 2(2), February.

Radebaugh, L. H., Gebhardt, G., Gray, S. J., 1995. Foreign Stock Exchange Listing: A Case Study of Daimler-Benz, Journal of Financial Management and Accounting 6 (2), 158-192.

Roll, R., 1984. A simple implicit measure of the bid-ask spread in an efficient market, Journal of Finance 39, 1127-1139.

Stock, J., Watson, M., 1988. Testing for common trends, Journal of the American Statistical Association 83, 1097-1107.

Vlasic, B., Stertz, B., 2000. Taken for a Ride: How Daimler-Benz Drove Off With Chrysler. Harper Collins, New York, NY.

Appendix

Error correction modeling and price discovery

To formulate the dynamics of price adjustment across dual listings and detect the location of informed trades, consider the following common stochastic trend model of two price series, one constituting the DCX trades in Frankfurt (P_f) and the other the DCX trades in New York (P_{ny}). Suppose the continuous sequence of implicit efficient prices for DCX is an I(1) series that can be represented as a random walk,

$$(1A) \qquad P_t = P_{t-1} + w_t \qquad\qquad w \overset{iid}{\sim} N(0, \sigma_w^2)$$

where t is trading time and w_t is a random information arrival over the interval of trading time between P_{t-1} and P_t. Because P_t exhibits no tendency to mean revert, information arrivals lead to permanent shocks that cumulate over the time between synchronous trades into a stochastic trend $\sum w_t$,

$$(2A) \qquad P_T = P_0 + \sum_{t=1}^{T} w_t \, .$$

where both exchanges trade at time t=1 and then again at time t=T. Across competing exchanges, it is the first to impound this Stock-Watson (1988) common stochastic trend into actual trading prices that we associate with an event of price discovery.

Trading prices in both exchanges are assumed to be I(1) and impound the stochastic trend of the implicit efficient price P_T as a common factor:

$$(3A) \quad P_{f,T} = P_{f,0} + \sum_{t=1}^{T} w_t + \varepsilon_{f,T} \qquad \text{and} \qquad P_{ny,T} = P_{ny,0} + \sum_{t=1}^{T} w_t + \varepsilon_{ny,T}.$$

where each price is assumed to depend on a non-stochastic initial value, on the permanent trend of the cumulated random information arrivals $\sum_{t=1}^{T} w_t$, and on a zero-mean covariance-stationary process that is transitory ($\varepsilon_{f,t}$ or $\varepsilon_{ny,t}$). The $\varepsilon_{f,T}$ and $\varepsilon_{ny,T}$ are disturbances to private values that reflect differences of opinion in assessing the same information, differences in depths at the prior quote and thus differential

order imbalance, or differences in market frictions. Although it is plausible to assume that w_t cannot be forecasted from prior knowledge of ε_t, the transitory shocks themselves may not be independent. Instead, we expect the order imbalance in Frankfurt to be correlated with the order imbalance in New York.

Noting that the difference between the contemporaneous values in equation (3A),

$$(4A) \qquad (P_{f,t} - P_{ny,t}) = \varepsilon_{f,t} - \varepsilon_{ny,t}$$

is itself a stationary time series, we can appeal to the Granger Representation Theorem for cointegrated variables (Engle and Granger, 1987). When linear combinations of integrated I(1) variables like $P_{f,t}$ and $P_{ny,t}$ are stationary, the underlying series are cointegrated. Therefore, $\Delta P_{f,t}$ and $\Delta P_{ny,t}$ can be estimated as a vector error correction model (VECM):

$$(5A) \quad \Delta P_{f,t} = \left(\sum_{j=1}^{2} \sum_{t=1}^{S} \beta_{fj,t-s} \Delta P_{j,t-s} \right) + \gamma_f \left(P_{f,t-1} - P_{ny,t-1} \right) + u_{f,t}$$

$$(5A') \quad \Delta P_{ny,t} = \left(\sum_{j=1}^{2} \sum_{t=1}^{S} \beta_{ny\,j,t-s} \Delta P_{ny,t-s} \right) + \gamma_{ny} \left(P_{f,t-1} - P_{ny,t-1} \right) + u_{ny,t}$$

where j is the number of exchanges, S is the optimal lag length that minimizes the AIC information criterion for the corresponding VAR system of price level equations, and $u_{j,t}$ is an unrestricted error term.[25]

Writing innovations in the trading prices as $\Delta P_{j,t-s} = w_{t-s} + \Delta \varepsilon_{j,t-s}$ and substituting into (5A) and (5A') yields,

$$(6A) \quad \Delta P_{f,t} = \alpha_f + \sum_{j=1}^{2} \beta_{f,j} \sum_{t=1}^{S} w_{t-s} + \sum_{j=1}^{2} \sum_{t=1}^{S} \beta_{f,j,t-s} \Delta \varepsilon_{j,t-s} + \gamma_f (\varepsilon_{f,t-1} - \varepsilon_{ny,t-1}) + u_{f,t}.$$

$$(6A') \quad \Delta P_{ny,t} = \alpha_{ny} + \sum_{j=1}^{2} \beta_{ny,j} \sum_{t=1}^{S} w_{t-s} + \sum_{j=1}^{2} \sum_{t=1}^{S} \beta_{ny,j,t-s} \Delta \varepsilon_{j,t-s} + \gamma_{ny} (\varepsilon_{f,t-1} - \varepsilon_{ny,t-1}) + u_{ny,t}.$$

Equations (6A) and (6A') make clear that the error correction parameter γ reflects the adjustment to cointegration equilibrium necessitated by transitory shocks idiosyncratic to each market ($\varepsilon_{j,t}$), whereas $\Sigma\beta_{f,}$

[25]In general, the error term is unrestricted, but of particular relevance to our estimation procedure is the possible correlation of the u_t across equations.

$_j$ or $\Sigma\beta_{ny,\,j}$ refers to the long-run equilibrium impounding in $P_{f,\,t}$ or $P_{ny,\,t}$ of lagged innovations in the common factor. In a two-variable model the VECM is just identified, so that estimating the d parameters with (5A) and (5A') is sufficient to derive the $\Sigma\,\beta_{kj}$ and $\beta_{kj,t-s}$ parameters and thereby separate the permanent and transitory effects.

Harris, McInish, Shoesmith, and Wood (1995), Liberman, Ben-Zion, and Hauser (1999), and Harris, McInish and Wood (2002a, b) proceed in this manner with VECM testing. Under what we shall call a *one-way price discovery* alternative hypothesis, $\Delta\,P_{ny,\,,t}$ error corrects to equilibrium deviations between the Frankfurt and New York prices, but not the other way around. With the Frankfurt trading price P_f as theoretically the sole source of price discovery, one-way impounding of new information implies one-way error correction. A statistically significant error correction term in one but not both equations (5A) and (5A') rejects the *hypothesis of multilateral price discovery* in favor of this one-way alternative.

Estimation and testing of common factor weights

If, as expected, arbitrage quickly removes any deviations in the most recent trading prices ($P_{f,\,,t-1} - P_{ny,\,t-1}$), then we expect $P_{f,t}$ and $P_{ny,t}$ to be cointegrated, under both the one-way and two-way price discovery hypotheses. To confirm the appropriateness of these restrictions, we pretest the order of integration and the hypothesized cointegration of these Frankfurt and New York synchronous prices using the augmented Dickey-Fuller and Johansen tests. With r cointegrating vectors, there are $k = n - r$ common factors corresponding to the $n - r$ common stochastic trends. Here, we anticipate that the maximal eigenvalue and trace tests for cointegration will reveal one cointegrating vector and imply therefore one common stochastic trend corresponding to $\sum_{t=1}^{T} w_t$ in our foregoing model structure.

Grammig, Melvin, and Schlag (2001) find that in cross-listings, the exchange rate itself can be a source of an additional common stochastic trend. One DEM purchased 1.82 USD at the beginning of November 1998 but only 1.62 USD by the end of 1998 when the Euro was introduced. And the Euro continued this downward trend, depreciating from 1.14 USD in January 1999 to 1.04 USD in May. However, any bias in the common factor procedures we employ is tied to stochastic, not deterministic, trends. Hence, the magnitude of bias from ignoring exchange rate effects depends upon the difference in the variability of the two underlying price series attributable to the variation in the exchange rates. Over this period, the standard deviation of the quotes (that we used to adjust stock prices) was 0.028 in Euros and 0.034 in USDs. Such similar magnitudes of the exchange rate shocks to the German and U.S. prices indicate that a two-equation model of the prices in the two trading venues is warranted.

Having confirmed cointegrated series, we employ Gonzalo and Granger's (1995) common factor components procedure to measure and then test the proportion of the common stochastic trend emanating from the Frankfurt versus New York trades. First, write p cointegrated series as additively separable functions of k common factor(s) $\mathbf{f}_t$ and r stationary error correction terms $\mathbf{z}_t = \alpha' \mathbf{P}_t$ where α' is an r x p matrix of the cointegrating vectors and $\mathbf{z}_t$ is I(0),

$$(7A) \quad \mathbf{P}_t = \mathbf{A_1} \mathbf{f}_t + \mathbf{A_2} \mathbf{z}_t$$

$$(7A') \quad = \mathbf{A_1} \gamma_\perp' \mathbf{P}_t + \mathbf{A_2} \alpha' \mathbf{P}_{t-1}.$$

Let $\mathbf{P}_t$ be a p x 1 vector of cointegrated prices, $\mathbf{A_1}$ and $\mathbf{A_2}$ are loading matrices, and $\gamma_\perp'$ is a k x p matrix of common factor weights on the contemporaneous prices in the k common factor vector(s) $\mathbf{f}_t$ where k = (p - r). Gonzalo and Granger (1995) -- hereinafter GG -- show that under the above restrictions, the p x k matrix $\mathbf{A_1} = \alpha_\perp (\gamma_\perp' \alpha_\perp)^{-1}$ and the p x r matrix $\mathbf{A_2} = \gamma (\alpha' \gamma)^{-1}$. Since by definition $\gamma_\perp' \gamma = 0$, the coefficient vector γ on the error correction terms in the fully specified VECM in equations (5A) and (5A') provide a way to identify the permanent components $\gamma_\perp' \mathbf{P_t}$.

GG prove equation (7A') for their permanent-transitory decomposition,[26] and they show how to estimate $\boldsymbol{\gamma}_{\perp}$ with reduced rank regression and eigenvector computations similar to those used in the Johansen technique for estimating the cointegrating vectors $\boldsymbol{\alpha}' \mathbf{P}_t$. Most importantly, they also develop a χ^2 distributed test statistic (Q_{GG}) for the elements of the common factor vector $\gamma_{\perp j}$. Because of the linear combination restriction on the $\gamma_{\perp j}$, these parameters can be normalized and interpreted as a vector of factor weights on the underlying time series that together are responsible for the multivariate cointegration.

GG common factor weights provide a direct test of intermarket price adjustment across cointegrated security markets. To examine the null hypothesis of two-way price adjustment, the common factor weights can be tested separately or in subgroups as significantly greater than zero --i.e., $H_0 : \gamma_{\perp j} > 0$ and $H_a : \gamma_{\perp j} = 0$. Thus, one can test whether the Frankfurt trades are in fact responsible for revealing 100% of the common factor.

GG's reduced rank estimation procedure offers convenient hypothesis testing on the loading matrix of factor weights despite contemporaneous correlation of cross-equation, cross-market disturbances—i.e., the u_t in the system of equations (5A) and (5A'). Hasbrouck (1995) offers a related cointegration/error correction measure of the price discovery across informationally linked markets. However, Hasbrouck's information shares methodology depends on the ordering of variables in the Cholesky factorization of the residual covariance matrix, and the discrepancies between the orderings may be large as the contemporaneous correlation of disturbances across the markets increases (Baillie, Booth, Tse, Zabotina, 2002 and Huang, 2002).[27] For this reason, we adopt the GG procedure to estimate our model.

---

[26]GG restrict the transitory ε disturbances to not Granger-cause the w permanent information arrivals, and they restrict the common factors to linear (i.e., additively separable) functions of the current observable prices. de Jong (2002), Harris, McInish, and Wood (2002a, b) and Hasbrouck (2002) debate these restrictions.

[27]By using an extremely high frequency (one-second) resolution of quote data, Hasbrouck (1995) effectively mitigated this problem by minimizing the cross-equation error covariance.

Table 1. Market metrics for DCX. For DCX, we report the mean trade price, number of trades, trade size, and spreads for the NYSE (panel A) and FSE (panel B). The merger of Daimler and Chrysler was consummated by an exchange of shares on October 27, 1998 and trading in these shares began on November 17, 1998. For the NYSE data (Panel A), we report the quoted spread, the effective spread, and the implicit spread. The quoted spread is the difference between the best ask and best bid price divided by 2. The effective spread is calculated as twice the absolute value of the difference between the trade price and the most recent quote midpoint. The quoted and effective spreads are in U.S. dollars. Following Roll (1984), the implicit spread is calculated as $2\sqrt{-c}$, where c is the covariance of returns.

	1998		1999				
	Nov.	**Dec.**	**Jan.**	**Feb.**	**March**	**April**	**May**
Panel A: New York Stock Exchange							
Trade price	$89.00	$91.36	$104.37	$97.27	$89.55	$95.64	$94.28
No. of trades	15,250	19,739	18,569	11,346	18,069	14,645	9,936
Trade size							
Mean	1,914	1,897	1,435	1,170	1,110	1,256	1,217
St. Deviation	6,181	5,114	3,832	3,046	2,966	4,192	3,462
Minimum	100	100	100	100	100	100	100
Maximum	339,000	250,000	175,700	100,000	102,000	162,700	171,000
Implicit spread	0.092	0.077	0.091	0.096	0.108	0.089	0.090
Effective spread	0.088	0.088	0.100	0.106	0.112	0.102	0.108
Quoted spread	0.188	0.190	0.226	0.238	0.245	0.222	0.246
Panel B: Frankfurt Stock Exchange							
Trade price	$87.27	$91.47	$104.18	$97.44	$89.65	$96.52	$94.69
No. of trades	24,025	30,145	34,953	25,740	33,279	34,848	24,221
Trade size							
Mean	2,187	1,790	1,751	1,683	1,706	1,717	1,731
St. Deviation	2,746	1,994	1,945	1,736	1,816	1,763	1,841
Minimum	1	1	1	1	1	1	1
Maximum	95,000	25,800	71,200	23,400	25,000	22,900	95,000
Implicit spread	0.067	0.065	0.067	0.057	0.066	0.050	0.048

Table 2. Components of the NYSE spread. For DCX, we report the adverse selection cost (panel A) and order processing cost (panel B) components of the effective spread estimated using the approach of Lin, Sanger, and Booth (1995). For November 1998 we classify each trade into one of five categories based on its size relative to other trades in the entire sample. The five categories are formed according to percentile ranking (<25 comprises trades with a size less than the 25th percentile). We report our results for the entire sample and for the five trade size categories. We repeat the analysis for each subsequent month through May 1999.

	1998		1999				
	Nov.	**Dec.**	**Jan.**	**Feb.**	**March**	**April**	**May**
Panel A: Adverse selection cost							
<25	0.025	0.049	0.010	0.042	0.074	0.036	0.125
25-50	0.010	0.055	0.090	0.011	0.030	0.029	0.141
51-75	0.012	0.120	0.008	0.020	0.060	0.160	0.060
76-90	0.037	0.047	0.137	0.438	0.132	0.151	0.179
90>	0.487	0.208	0.208	0.203	0.506	0.199	0.200
Entire sample	0.041	0.070	0.038	0.062	0.074	0.069	0.117
Panel B: Order processing cost							
<25	0.001	0.002	0.002	0.001	0.029	0.001	0.072
25-50	0.018	0.001	0.001	0.029	0.084	0.543	0.010
51-75	0.001	0.021	0.033	0.001	0.001	0.034	0.035
76-90	0.045	0.086	0.086	0.078	0.283	0.138	0.338
90>	0.001	0.300	0.001	0.543	0.172	0.047	0.531
Entire sample	0.001	0.007	0.001	0.001	0.044	0.200	0.047

Table 3. Time-series properties of synchronous trades in Frankfurt and New York. We report time-series properties of the underlying DCX trading price series on the FSE and NYSE. The order of integration of each separate series is tested with all the lags significant at 95% in a ten-lag model of the price levels. Augmented Dickey-Fuller test statistics without (column 2) and with (column 3) drift intercept terms confirm that each series is I(1) relative to critical values of –1.62 and –2.57, respectively. The chi-square tests of residuals (column 4) in the unconstrained Johansen simultaneous least squares equations show white noise residuals. An optimal system lag length (last column) estimated by minimizing the Aikake Information Criterion (AIC) is two lags for the system of VAR equations formed from both trade price series.

	Augmented Dickey-Fuller Test Statistics		**χ2 test of residuals**	**AIC optimal lag length**
	without intercept	**with intercept**		
Frankfurt Stock Exchange	-0.75	-1.49	0.17	2
New York Stock Exchange	-0.73	-1.54	1.01	2

Table 4. Common factor weights for price discovery in New York and Frankfurt. For the hours in which both exchanges are open, we compare the contribution to price discovery of synchronous NYSE and FSE price series. Each trade is adjusted for the EUR/USD exchange rate quotation using transaction data from Olsen Associates. We report results of the cointegration and common factor tests. Turning first to the cointegration analysis, the null hypothesis is H_0:r = 0 and the alternate hypothesis is H_a:r =1. Trace (column 2) and Hmax (column 3) are the Johansen cointegration test statistics. The 5% critical value is 8.08 with rejection of the null hypothesis of no cointegration indicated by a single star. The conclusion (column 4) summarizes whether the underlying variables are cointegrated at order one. Σ_γ is the sum of the magnitudes of the cointegrating vector (suggesting the magnitude of possible arbitrage profit opportunities). Next, the results of the common factor analysis are presented in the last two columns; fFR and f_{NY} are the common factor weights for the P_{FR} and P_{NY} price series. Statistical significance at a 5% critical value is indicated by a single star.

	Cointegration results				**Common factor results**	
	Cointegration tests					
	Trace	**Hmax**	**Conclusion**	**$\sum\gamma$**	**f_{FR}**	**f_{NY}**
January	10.41*	9.57*	C(1)	-0.300	0.537	0.463
February	8.51*	7.82	C(1)	0.127	0.587	0.413
March	11.65*	11.24*	C(1)	-0.209	0.895*	0.105
April	26.60*	25.43*	C(1)	0.189	0.908*	0.092
May	13.04*	13.03*	C(1)	0.185	0.830*	0.170

Table 5. Error-correction models. For each series in the two-variable information structure, we present estimates and t-scores of the error correction model for log changes. The error-correction term, Z(t-1), is specified as (minus) the difference P_{NY} - P_{FR} for the New York and Frankfurt price series. The error correction term has the expected sign and is statistically significant at the 0.01 level in the New York price change equation, but is insignificant in the Frankfurt equation. This five-month (January-May) estimation is consistent with the one-way price discovery from Frankfurt to New York detected in the common factor estimates (see Table 4) for March, April and May.

VECTOR ERROR CORRECTION MODEL

ΔPRICE (FRANKFURT)			**ΔPRICE (NEW YORK)**		
Constant	-0.001	(-0.02)	Constant	0.002	(6.27)*
$\Delta PRICE_{FR}$ (t-1)	-0.162	(-4.96)*	$\Delta PRICE_{FR}$ (t-1)	0.093	(2.86)*
$\Delta PRICE_{FR}$ (t-2)	-0.048	(-1.54)	$\Delta PRICE_{FR}$ (t-2)	0.051	(1.62)
$\Delta PRICE_{NY}$ (t-1)	0.153	(4.70)*	$\Delta PRICE_{NY}$ (t-1)	-0.104	(-3.21)*
$\Delta PRICE_{NY}$ (t-2)	0.044	(1.42)	$\Delta PRICE_{NY}$ (t-2)	-0.053	(-1.69)
Z(t-1)	0.00017	(0.06)	Z(t-1)	0.019	(6.37)*
F Statistics			F Statistics		
Model	5.54*		Model	14.82*	
$\Delta PRICE_{FR}$	12.31*		$\Delta PRICE_{FR}$	4.37*	
$\Delta PRICE_{NY}$	11.06*		$\Delta PRICE_{NY}$	5.42*	
Z (t-1)	0.00		Z (t-1)	40.6*	

* Signifies significance at 1%

The estimated vector error correction model is:

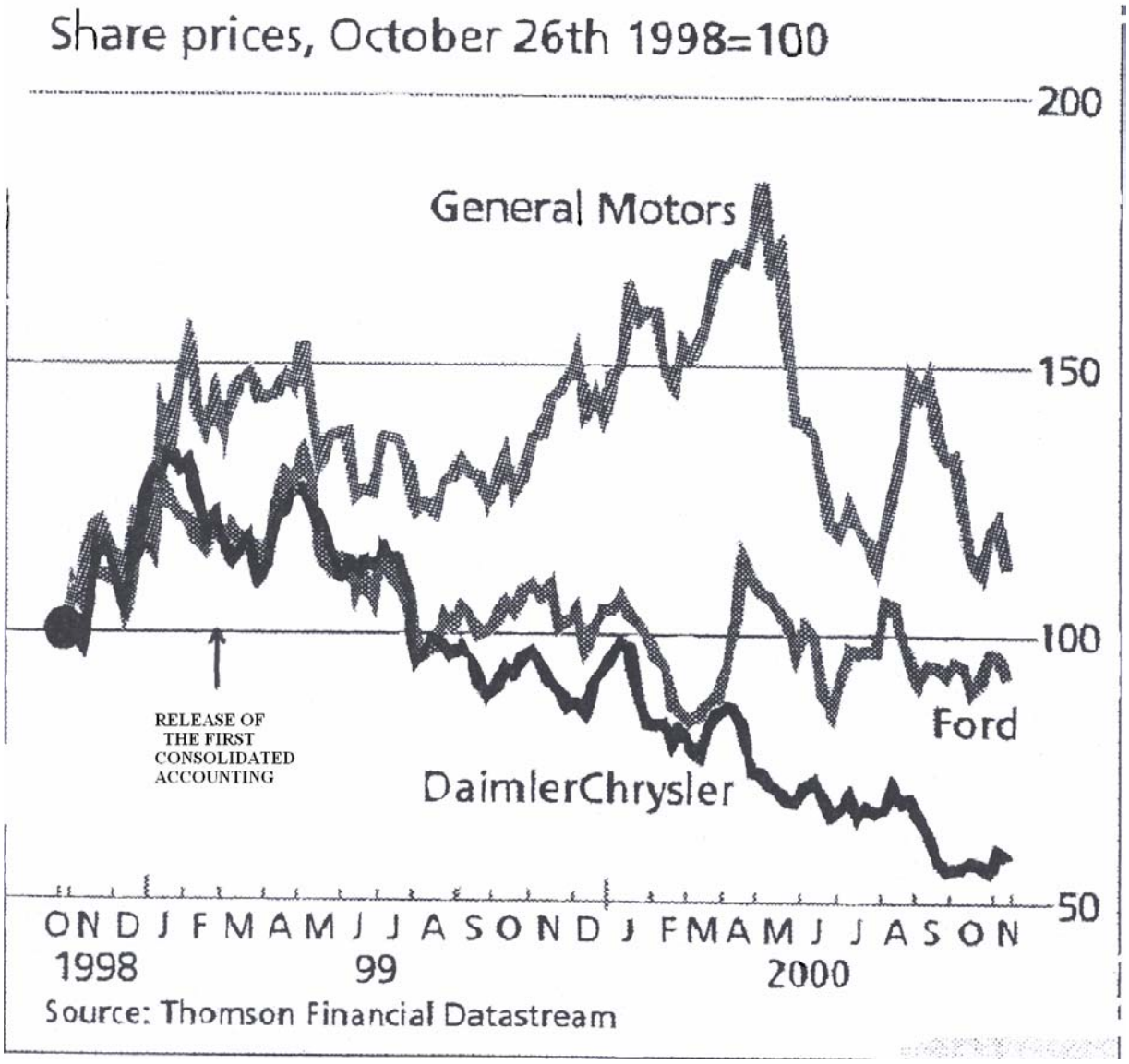
$$\Delta P_{FR} = \alpha_{FR} + \sum_{i=1}^{2} \beta_{FR,t-i} P_{FR,t-i} + \sum_{i=1}^{2} \beta_{NY,t-i} P_{NY,t-i} - \gamma_{FR}(P_{NY} - P_{FR})_{t-1}$$

$$\Delta P_{NY} = \alpha_{NY} + \sum_{i=1}^{2} \beta_{NY,t-i} P_{NY,t-i} + \sum_{i=1}^{2} \beta_{FR,t-i} P_{FR,t-i} - \gamma_{NY}(P_{NY} - P_{FR})_{t-1}.$$

Figure 1. Timeline of DCX events in the twelve months following the merger announcement

May-98	Sep-98	Oct-98	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99
Merger announced	Merger Approved	Deletion from S & P 500	First day of trading			1998 consolidated results released	1998 annual report and 20-F released U.S. sell off	U.S. sell off
DCX Stock Price			$82	$99	$108	$97	$89	$96
% U.S. Ownership			44%					21%
% NYSE Trades			28%	17%	14%	10%	8%	5%
U.S. Institutional Shares				67.7 million			54.5 million	

Figure 2


Share prices, October 26th 1998=100
200
150
100
50
General Motors
Ford
DaimlerChrysler
RELEASE OF THE FIRST CONSOLIDATED ACCOUNTING
O N D J F M A M J J A S O N D J F M A M J J A S O N
1998
99
2000
Source: Thomson Financial Datastream

about ECGI

The European Corporate Governance Institute has been established to improve *corporate governance through fostering independent scientific research and related activities.*

The ECGI will produce and disseminate high quality research while remaining close to the concerns and interests of corporate, financial and public policy makers. It will draw on the expertise of scholars from numerous countries and bring together a critical mass of expertise and interest to bear on this important subject.

The views expressed in this working paper are those of the authors, not those of the ECGI or its members.

ECGI Working Paper Series in Finance

Financial assistance for the services of the editorial assistant of these series is provided by the European Commission through its RTN Programme on Understanding Financial Architecture: Legal and Political Frameworks and Economic Efficiency (Contract no. HPRN-CT-2000-00064).

Electronic Access to the Working Paper Series

The full set of ECGI working papers can be accessed through the Institute's Web-site (www.ecgi.org/wp) or SSRN:

Finance Paper Series	http://www.ssrn.com/link/ECGI-Fin.html
Law Paper Series	http://www.ssrn.com/link/ECGI-Law.html