International Review of Financial Analysis 56 (2018) 136–152

Contents lists available at ScienceDirect

International Review of Financial Analysis

journal homepage: www.elsevier.com/locate/irfa

The interactions between price discovery, liquidity and algorithmic trading for U.S.-Canadian cross-listed shares☆

Bart Frijns, Ivan Indriawan*, Alireza Tourani-Rad

Auckland University of Technology Auckland, New Zealand

ARTICLE INFO

Keywords:
Market microstructure
Price discovery
Cross-listings

JEL classification:
C32
G15

ABSTRACT

We analyze price discovery dynamics for Canadian companies cross-listed on the NYSE from January 2004 to August 2017. We employ a structural vector autoregression to assess the interactions between price discovery, liquidity and algorithmic trading activity. We observe that over time, the U.S. market is gaining dominance in terms of price discovery. Improvements in liquidity increase a market's contribution to price discovery, and vice versa. We find that algorithmic trading activity is negatively related to price discovery, indicating negative externalities of high-frequency trading. These results are robust to fragmentation in the Canadian financial markets as well as regulatory changes in both the U.S. and Canada.

1. Introduction

One of the central functions of financial markets is price discovery, the process by which prices impound new information (Madhavan, 2000). Price discovery is important because it reflects how well a market gathers, interprets, and incorporates new information into prices. It also emphasizes the importance of obtaining the most current information for decision making, i.e. when market participants adjust their expectations on an asset's fundamental value and update their prices. When an asset is listed in multiple markets, price discovery plays an even more important role as information can be incorporated into prices in any market where the security is listed. In such a case, the market which incorporates new information into prices the fastest, has better information processing capacity than other markets and leads in terms of price discovery. Thus, in a multi-market context, price discovery reflects one form of competitiveness of a market relative to others. Such a competitive advantage may attract more investors to that market leading to an improvement in liquidity in that market.

Given the importance of price discovery in a multi-market setting, it is crucial for exchanges to understand which market contributes more to price discovery, and which factors lead to improving a market's contribution to price discovery. Price discovery may shift from one market to another over time for several reasons, one of them being liquidity. Admati and Pfleiderer (1988) explain that a liquid market attracts liquidity traders and that trading will become more concentrated. A liquid market also attracts more informed traders because such a market is “thick” and informed traders can exploit their private information without making large price concessions. At the same time, liquid markets may attract more analysts which further improves the informational environment. Overall, an increase in liquidity could thus lead to an improvement in price discovery for that market. An interesting recent development that can affect price discovery is the upsurge in algorithmic trading (AT). AT accelerates the speed at which traders can detect and exploit price discrepancies among securities, thus it can potentially enhance price discovery. However, such improvement may come at a cost to other traders who are disadvantaged in terms of speed, and may opt to trade in the other market, leading to a reduction in price discovery. These arguments suggest that price discovery will not remain constant, but will vary over time.

Currently, a clear understanding of how price discovery changes over time and what drives such dynamics, is lacking. For instance, the questions of whether price discovery is persistent over time, or whether the dynamics of price discovery is attributable to changes in market liquidity or AT activity are still to be understood. In addition, whether improvements in price discovery lead to more market liquidity is not known. To address these questions, studying price discovery over a

☆ We thank Robert Faff, Yiuman Tse, Robert Webb, the participants at the 2014 Auckland Finance Meeting, the 2017 New Zealand Finance Colloquium, and the seminar participants at Auckland University of Technology, Massey University, Victoria University of Wellington for their helpful comments and suggestions. We thank the Securities Industry Research Centre of Asia-Pacific (SIRCA) for the Best Paper Award during the 2017 New Zealand Finance Colloquium.

* Corresponding author at: Department of Finance, Auckland University of Technology, Private Bag 92006, Auckland 1020, New Zealand
E-mail address: ivan.indriawan@aut.ac.nz (I. Indriawan).

https://doi.org/10.1016/j.irfa.2018.01.005
Received 10 April 2017; Received in revised form 22 November 2017; Accepted 8 January 2018

longer time period is necessary. Existing studies tend to examine price discovery over relatively short periods.[1] As such, these studies lean towards explaining cross-sectional differences in price discovery, rather than the dynamics of price discovery and liquidity over time. The importance of studying price discovery over longer periods is further emphasized by the changing financial market landscape as a result of, for example, regulatory changes. One such change is the adoption of the Order Protection Rule which was intended to improve fairness in price execution, and to improve the displaying of quotes and access to market data. Such regulation helps create a more integrated market, and may therefore, affect a market's contribution to price discovery.

In this paper, we assess the interactions between price discovery, liquidity and algorithmic trading for a sample of Canadian stocks traded in Canada and the U.S. Our work contributes to the literature in several ways. First, by computing daily measures of the Hasbrouck (1995) information share (IS) and Gonzalo and Granger (1995) permanent-transitory (PT) decomposition over a long period, we are able to explore trends and persistence in price discovery, issues that have hardly been explored in a multi-market context. This also allows us to examine whether the implementation of the Order Protection Rule affected the dynamics of price discovery. Second, we assess how measures of price discovery, liquidity, and AT activity interact with each other over a longer period. Our analyses shed light on what drives price discovery between markets (i.e. whether changes in relative liquidity and AT activity affect the contribution to price discovery of a market), as well as the importance of price discovery for a market (i.e. whether an improvement in price discovery affects liquidity and AT activity).[2] These findings are valuable for exchanges as they indicate what areas they would need to focus on to improve price discovery. Third, from an empirical perspective, we model the interactions between price discovery measures, liquidity, and AT activity using a structural vector autoregression (SVAR). In contrast to the reduced-form Granger causality tests, which measure predictive relationships, the SVAR allows for the identification of contemporaneous interactions among the variables, while at the same time, taking into account the possible endogeneity among them. This is done using the identification through heteroskedasticity approach developed by Rigobon (2003), which was recently implemented by Chaboud, Chiquoine, Hjalmarsson, and Vega (2014).[3]

Applying our model to Canadian stocks listed on the Toronto Stock Exchange (TSX) and cross-listed on the New York Stock Exchange (NYSE) over the period January 2004 to August 2017, we document several important findings. First, we observe that over time, the U.S. market is gaining in terms of price discovery. Second, we find that several measures of liquidity are causally related to price discovery. Improvements in liquidity (an increase in trading volume and a decrease in effective spread) increase an exchange's contribution to price discovery, implying that the market which provides better liquidity will become more important in terms of price discovery. This impact is incorporated instantaneously (within the same day) as well as with a protracted lag (after several days). Conversely, we find that an increase in price discovery leads to improved liquidity, indicating that the market which leads in terms of price discovery becomes more liquid. Third, we find that in the case of cross-listed stocks, algorithmic trading activity negatively affects price discovery. This is in line with the crowding-out effect which has been documented in the literature (Stein, 2009; Gai, Yao, & Ye, 2014; Egginton, Ness, & Ness, 2016). In particular, as high-frequency traders compete aggressively with one another to create latency arbitrage opportunity, they push away other traders who are disadvantaged in terms of speed. Finally, we find that the dynamic relations between price discovery, liquidity and AT activity persist even after we account for the adoption of the Order Proctection Rule both in the U.S. and Canada. Overall, our findings highlight the importance of liquidity for exchanges to improve price discovery, as well as the importance of price discovery to attract more investors. The impact of high-frequency trading on financial markets should be of interest to exchange officials because while it may improve price discovery for the faster traders, the crowding out effect may hinder the price discovery of the market as a whole.

The rest of this paper is structured as follows. Section 2 discusses existing studies on the determinants of price discovery and how our work contributes in this field. In Section 3, we present the data and report descriptive statistics, as well as our measures of liquidity and AT activity. We discuss our measures for price discovery as well as the models for assessing dynamics in price discovery in Section 4. In Section 5, we report our findings. Section 6 concludes.

2. Literature review

A market's contribution to price discovery may change over time for various reasons. In this section, we first discuss factors that may contribute to the change in price discovery over time. We then show how these factors can be modeled to assess the dynamics of price discovery in a dual-market scenario.

There is a growing literature examining price discovery of cross-listed stocks. The majority of it focuses on the determinants of price discovery, with liquidity playing an important role. As discussed in Admati and Pfleiderer (1988), one of the motives for trade in financial markets is traders' preference for liquidity. Given that investors have discretion over where and when to trade, they have the tendency to trade in cheaper and more liquid markets, i.e. when the market is “thick” and their trading has little effect on prices. Such a market may attract more traders, leading to information clustering and a shift in price discovery.

One type of liquidity, which is important for price discovery, is trading volume. It is often observed that large trades have a persistent price impact, with trade prices lower after large sales and higher after large purchases. One possible explanation is that increased volume reflects a greater likelihood that demand for a stock comes from informed traders (Stickel & Verrecchia, 1994). Consequently, investors interpret high volume as an indication that the demand underlying a price change is informative, and therefore should get incorporated into prices. Consistent with this view, Hasbrouck (1995) finds a positive and statistically significant relation between the relative trading volume of a sample of 30 Dow stocks and the NYSE's contribution to price discovery. He explains that markets differ in their ability to process information such as that coming from trades. A market which has an informative trading process can shed light on the interpretation of public information, and therefore, leads in terms of price discovery. Similarly, Pascual et al. (2006) find that a market's relative contribution to the price discovery process is related to its trading activity. Using Spanish stocks that are cross-listed on the NYSE, they find that the Spanish Stock Exchange leads in terms of price discovery due to its large trading activity relative to the NYSE as the satellite market.

[1] For instance, Pascual, Pascual-Fuster, and Climent (2006) study Spanish firms cross-listed on the NYSE for the year 2000. Eun and Sabherwal (2003) study Canadian firms cross-listed on the NYSE from February to July 1998, while Chen and Choi (2012) use data from January 1998 to December 2000.

[2] The analysis of the impact of AT activity on price discovery is especially relevant given that AT activity proliferated in the U.S. and Canada at different times. Hence, price discovery between the two markets may have changed over time. In the U.S., high-frequency trading, a subset of AT, became especially popular in 2007 and 2008 (Rogow, 2009, June 19). By 2009, 26 high-frequency traders participate in 68.5% of the dollar volume traded on average (Brogaard, 2010). Gibbs (2007) explains that U.S. players will continue to dominate the market because while Canadian traders ramp up their algorithmic capabilities, they tend to partner with U.S. broker-dealers to leverage their offerings.

[3] The idenfitication through heteroskedasticity approach was recently applied in several finance studies. For example, Chaboud et al. (2014) use the approach to identify the contemporaneous causal impact of AT on triangular arbitrage opportunities. Badshah, Frijns, and Tourani-Rad (2013) use the same approach to assess contemporaneous spillover effects among equity, gold, and exchange rate implied volatility indices. Ehrmann, Fratzscher, and Rigobon (2011) use a similar model to assess international transmission of shocks between money, bond, equity and foreign exchange markets.