Toxic Arbitrage

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Abstract

Arbitrage opportunities arise when new information affects the price of one security because dealers in other related securities are slow to update their quotes. These opportunities are toxic since they can result in a trading loss for liquidity suppliers with stale quotes. We develop a measure of dealers' exposure to toxic arbitrage trades. Using data on high frequency triangular arbitrage opportunities in the FX market, we show that an increase in dealers' exposure to toxic arbitrage trades has a significant positive effect on trading costs. The finding suggests a possible harmful effect of high frequency arbitrage activities.

Keywords: arbitrage, adverse selection, liquidity, high frequency trading

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I. Introduction

Arbitrageurs are critical for well functioning securities markets. When one asset becomes mispriced relative to another security, they step in, buying the relative expensive asset and selling the cheap asset, bringing prices back in line. In this way, arbitrageurs make markets more efficient. In addition, the literature on limits to arbitrage (see Gromb and Vayanos (2010) for a survey) emphasizes the role played by arbitrageurs in liquidity provision. By trading against price pressures, arbitrageurs effectively act as liquidity providers. On this ground, one could expect arbitrageurs to enhance both market efficiency and market liquidity.

Instead, in this paper, we argue that arbitrage can have a negative effect on liquidity. The reason is that arbitrage opportunities (mispricings) sometimes arise because the prices of related securities do not adjust to new information at the same speed. Arbitrageurs' exploitation of these asynchronous price adjustments is a source of adverse selection for liquidity providers who adjusts their quotes relatively slowly, even though arbitrageurs may not be aware of the informational shock at the origin of the mispricing.

As an example, consider two "dealers" (or limit order books) A and B trading the same asset and suppose that good news regarding the asset arrives. One dealer, say A, instantaneously adjusts his bid and ask quotes to reflect the news while dealer B is slower in adjusting his quotes. If, as a result, dealer A's bid price exceeds dealer B's ask price momentarily, this asynchronous price adjustment gives rise to an arbitrage opportunity. If arbitrageurs are fast enough, they buy the asset from B before B updates his quotes and resell it to A. As a result, dealer B sells the asset at a price that is too low relative to its value and books a loss, as if he were trading against informed traders. Thus, in some cases, arbitrage can be "toxic", that is, it can generate trading losses for market makers.[1] Toxic arbitrage trades raise the cost of market-making and therefore should work to raise the cost of trading.

How large is the cost of toxic arbitrage trades? This question is important as the proliferation of new trading venues in securities markets (market fragmentation) and redundant securities (e.g., ETFs) creates new profit opportunities for arbitrageurs. These opportunities often arise due to very small delays ("latencies") in price adjustments of identical or similar assets traded in different platforms.

[1] Our definition of a toxic trade follows Easley et al. (2012). They write (p.1458): "Order flow is regarded as toxic when it adversely selects market makers who may be unaware that they are providing liquidity at a loss."

These small delays are exploited by a new breed of arbitrageurs – high frequency arbitrageurs – who enter and exit positions very quickly (often in fractions of a second). High frequency arbitrageurs play an important role in integrating markets but their activity is a source of concerns for regulators and market participants (see U.S. Securities and Exchange Commission (2010), Section B, p.51).

To evaluate the cost of toxic arbitrage trades, we use high frequency data for three currency pairs (dollar/euro, dollar/pound, and pound/euro) and study "triangular arbitrage" opportunities. For instance, at any point in time one can buy dollars with euros in two ways: (i) directly by trading in the dollar/euro market or (ii) indirectly by first buying pounds with euros and then dollars with pounds. If the price (in euros) of these two strategies differs then a triangular arbitrage opportunity exists. Our sample features 40,166 triangular arbitrage opportunities over two years (2003-2004). As other high frequency arbitrage opportunities, they have a very short life and generate very small profits after transaction costs (of the order of 1 to 2 bps). Thus, the nature of triangular arbitrage opportunities in our sample is very similar to those exploited by high frequency arbitrageurs, that is, short lived; almost riskless; and delivering a very small profit per trade.

As other arbitrage opportunities, triangular arbitrage opportunities arise for two reasons: (i) asynchronous price adjustments among currency pairs when information arrives or (ii) price pressures effects in one currency pair. Mispricings associated with price pressures effects should give rise to reversals (transient shifts in exchange rates) whereas those due to asynchronous price adjustments should be associated with permanent shifts in exchange rates. Thus, we use price patterns following the occurrence of an arbitrage opportunity to sort opportunities in our sample into two categories: toxic (that is, due to asynchronous price adjustments) and non toxic (due to price pressures effects). Using a conservative classification scheme, we obtain 17,368 toxic arbitrage opportunities (about 34 per day and 43% of all arbitrage opportunities in the sample).

The prevalence of toxic arbitrage opportunities in a given day is not in itself a good proxy for dealers' exposure to toxic arbitrage trades. Indeed, a toxic arbitrage opportunity does not necessarily give rise to a trade if dealers are fast enough to update their quotes when a toxic opportunity arises. Thus, dealers' exposure to toxic arbitrage is higher when arbitrageurs react relatively faster to a toxic arbitrage opportunity than dealers. We formalize this intuition in a simple model of toxic arbitrage in which traders' speeds of reaction to toxic arbitrage opportunities are endogenous and determined by traders' monitoring costs. The central prediction of the model is that an increase in the ratio of arbitrageurs' speed of reaction to a toxic arbitrage opportunity to dealers' speed of reaction to this opportunity (henceforth the "speed ratio") induces dealers to post larger bid-ask spread. The model also shows that the speed ratio can be proxied by the frequency with which an arbitrage opportunity is "closed" with a trade by an arbitrageur (the submission of market orders by arbitrageurs) instead of a quote update. We refer to this frequency as the PTAT measure (PTAT stands for the "probability of a toxic arbitrage trade"). In our sample, the daily average value of the PTAT measure is equal to 74%, meaning that about 3/4 of all toxic arbitrage opportunities are closed by arbitrageurs' trades rather than dealers' quote updates.

The model implies that, conditional on the occurrence of a toxic arbitrage, an increase in the PTAT should raise the cost of trading, that is, market illiquidity. To identify this effect, we use a technological change in the organization of the trading platform on which the three currencies considered in our paper are traded (Reuters D-3000). Until July 2003, traders had to manually submit their orders to this trading platform, which was slowing down the speed at which arbitrageurs could exploit triangular arbitrage opportunities. As of July 2003, Reuters gave the possibility to traders to automate order entry, which intuitively enabled arbitrageurs to react faster to arbitrage opportunities. In support of this hypothesis, we show that the automation of order entry on Reuters D-3000 is associated with shorter toxic triangular arbitrage opportunities (by 0.1 second, a 5.4% reduction in the average duration of these opportunities) and an increase of about 4% in the PTAT measure. Using the automation of order entry on Reuters D-3000 as an instrument for the PTAT measure, we find that a 1% increase in the PTAT is associated with a about 0.1 basis points increase in quoted bid-ask spreads in our sample (3 to 7% of the average bid-ask spread depending on the currency pair). Similar results are obtained when we use effective spreads or the slope of limit order books (a measure of market depth) as measures of market illiquidity. Given the volume of trade in currency markets, dealers' exposure to toxic arbitrage appears to be a significant source of illiquidity.

Overall these findings suggest that high frequency arbitrage may raise the cost of trading by increasing liquidity providers' exposure to adverse selection, especially if a large fraction of high frequency arbitrage opportunities arise due to asynchronous price movements. Hendershott et al. (2011) use the automation of order entry ("Autoquote") on the NYSE as an instrument to study the effect of algorithmic trading and find a positive effect of algorithmic trading on market liquidity. Using a similar technological change, we find an opposite effect. One possible reason is that we focus our analysis on aggressive orders (i.e., market orders) taking advantage of arbitrage opportunities. In contrast, Hendershott et al. (2011) do not specifically focus on one particular type of trades (strategy) for algorithmic orders. Hence, their finding may pick the average effect of various computerized strategies while our findings pick the effect of one of these strategies.

More generally our paper is related to papers on the role of speed in securities markets (e.g., Hendershott and Moulton (2011), Garvey and Wu (2010), or Hoffman (2012) or Pagnotta and Phillipon (2011)). As other papers (e.g., Biais et al. (2011) or Foucault et al. (2012)), our findings suggest that asymmetries in speeds of reaction among traders can be a source of adverse selection for slower market participants, and therefore a cause of market illiquidity.

Other papers (Dow and Gorton (1994), Kumar and Seppi (1994) or Edmans et al. (2012)) emphasize the connection between arbitrageurs and informed traders as we do in this paper. There are very few empirical papers on how arbitrage opportunities arise and disappear. Shultz and Shive (2010) is an exception. They show that profitable arbitrage opportunities exist in dual-class stocks because the bid price of the voting share sometimes exceeds the ask price of the non voting share. They also find that these arbitrage opportunities arise either from price pressures effects or asynchronous price adjustments, the former case being more frequent than the latter case (as in our sample). However, they do not study the effects of arbitrage opportunities due to asynchronous price adjustments on liquidity. To our knowledge, our paper is first to test whether arbitrage flows due to asynchronous price adjustments are a source of adverse selection and therefore illiquidity.

Last, our paper adds to the literature developing measures of liquidity providers' exposure to adverse selection. For instance, starting with Easley et al. (1996), several papers have used the PIN measure and variations thereof (e.g., Easley et al. (2012)) to assess dealers' exposure to privately informed traders. Here we attempt to measure dealers' exposure to adverse selection due to high frequency arbitrage trades triggered by asynchronous price adjustments of related securities when new information arrives.

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