A Taxonomy of Market Efficiency

Gregory H. Bauer

The Bank of Canada has a long-standing interest in the stability and efficiency of Canadian financial markets. In terms of efficiency, the Bank is concerned with how well the financial system allocates capital between savers and investors.

This article describes the three main definitions of market efficiency: informational, operational, and allocative. These concepts are described as they are used in finance theory.[1] One important point raised is that these three components of efficiency are linked via a hierarchy: the degrees of informational and operational efficiency help to determine the degree of allocative efficiency.[2] Some important policy implications arising from existing research are also examined.[3]

Informational Efficiency

An asset market is informationally efficient when the price of the asset incorporates all the information about its "fundamental value."[4] The definition is further refined depending on the information available to market participants. A market is "weak form" efficient if only the information in past prices is contained in the current price. This rules out using technical trading rules to make excess (i.e., risk-adjusted) returns.[5] A market is "semi-strong form" efficient if all public information is reflected in the asset price. This rules out trading on public information, such as dividend yields or interest rates, to make excess returns. A market is "strong form" efficient if prices contain all private and public information.[6] This rules out making excess returns via insider trading, because the prices already reflect that information.[7]

It is important to note that there is no such thing as a perfectly informationally efficient market (the Grossman-Stiglitz paradox). This can be demonstrated by examining what a perfectly efficient market would entail. In a market where the asset's price contained all private and public information, no one would have an incentive to do any research on the asset because no gains could be made from obtaining superior information. The lack of research implies that there would be no way for information to be incorporated into the asset price in the first place. Thus, the price of an asset could not contain all private and public information.

The best way to describe the informational efficiency of a market is by its degree of relative

1. The definitions provided here were used by Deputy Governor Sheryl Kennedy (2004).
2. For a summary of the evidence regarding Canadian capital market efficiency, see Hendry and King (2004).
3. Although the Bank of Canada does not have legislative authority to design and implement policy in most areas directly affecting informational and operational efficiency, the linkages between these and allocative efficiency motivate the Bank's involvement.
4. The fundamental value of an asset is the discounted sum of expected future cash flows from the asset, where the discount rate is the risk-free rate plus the expected risk premium on the asset.
5. Trading rules are "technical" when they are based only on movements in past prices and volumes.
6. Private (asymmetric) information is information known by sophisticated investors in the market but not known by ordinary investors. This could be (i) insider information about a particular firm; (ii) better forecasts of public information that has not yet been released; or (iii) a clearer understanding of information that is in the public domain. Information in the last two categories can affect either individual firms or groups of firms. In the finance literature, the role of private information on asset prices is examined by studying investors' order flow.
7. Note that trading by insiders may be either legal or illegal, depending on the context. See King and Padalko (2004) for further details.

efficiency. The amount of information in the asset's price is such that the marginal cost of producing the information is equal to the marginal benefit from trading on the information. At any given time, an asset's price does not reflect all available information, however defined. The interesting questions are: (i) how long does it take for information to be incorporated into prices, and (ii) how does the information get into the price? The first question is important because savers will want to know that the price of the asset they are investing in is "fair;" i.e., that they will not be negatively affected by previously known bad news after they invest. The second question relates to market integrity. If insiders have superior information that the asset is overvalued, how do ordinary investors get that information? Do the ordinary investors receive the information after the insiders have (illegally) traded the stock or in a public news release?

Informational efficiency is often confused with the idea of "random walks" in stock prices.[8,9] It is important to note that the two concepts are separate. If the risk premium on stocks is moving over time, then stock prices will change in response to current market conditions. Thus, stock prices will not be a random walk. However, if the market is semi-strong form efficient, no one will be able to make excess returns by trading on public information.

Policy implications

- Most research shows that markets react very quickly to public news announcements (e.g., interest rate shocks). However, such news appears to play a very small role in the dynamics of asset prices. Rather, the bulk of returns and volatility in stock, bond, and foreign exchange markets comes from the revelation of private information. It is therefore important for policy-makers in general to understand why some agents appear to have information superior to that of others and how this private information is released to the market. The Bank's research on market transparency is related to these issues.
- Lessons from previous work on small, open economies carries over to this line of research. Private and public information generated in the U.S. equity and money markets has an impact on Canadian equity prices. (See Albuquerque, Bauer, and Schneider 2004.) Importantly, a portion of this private information is related to the beliefs of sophisticated U.S. investors about the path of future U.S. interest rates (Bauer and Vega 2004).
- In general, smaller firms or markets will likely be less informationally efficient because fewer resources will be devoted to producing market research. This could be worrying for small firms in Canada or for the Canadian corporate bond market in aggregate. In addition, markets in the early stages of development (e.g., the Canadian credit-risk transfer market) are likely to be less informationally efficient and to contain more profit incentives for investors who do research.
- Small amounts of informational inefficiency can significantly affect the price of an asset. Suppose that the price of the asset equals its fundamental value, as described above. Under this definition, future cash flows are discounted by a rate composed of a risk-free rate plus an expected risk premium. Empirical work has shown that the expected risk premium is very "persistent" (i.e., the level of the risk premium next month is closely related to its value this month). If the current expected risk premium is "wrong" because of some inefficiency, the error will carry through to many future periods. Thus, the future cash flows from the asset will be discounted for some time by an expected return that is incorrect. This would significantly affect the current price. Thus, small changes in policies related to improving

8. Stock prices follow a "random walk" if the change in a stock's price cannot be forecast based on any available information.
9. Loosely speaking, an asset's price will follow a mathematical process called a "random walk" if all market participants are risk neutral, something not observed in everyday life. The "random walk" is a statistical model of prices that does not fit many real-world prices.

informational efficiency could have a major impact.[10]

- Tests of informational efficiency are complicated since they must be performed jointly with a test of the predictions of an asset-pricing model. For example, researchers cannot say, that the Government of Canada bond market is (relatively) informationally "efficient" without stating which asset-pricing model is used to evaluate the prices in the market. The problem for policy-makers is that there is no consensus as to the "right" asset-pricing model, suggesting that researchers have to temper their conclusions about informational efficiency. To understand the efficiency of a market, policy-makers must understand how prices are set in that market.

Operational Efficiency

Operational (or transactional) efficiency is a measure of the cost of transferring funds from savers to borrowers. It is thus concerned with transactions costs. In a perfect world, the transactions costs present in a market should (with competition) reflect the marginal costs of providing the services to the market participants.[11]

Work on operational efficiency is often concerned with the "liquidity" of a particular market: can investors trade in "reasonable" size without paying large transactions costs? (See for example, D'Souza 2002.) Finance theory shows that sophisticated investors (those with private information) trade in markets where there are many liquidity-based (i.e., non-informed) investors so that they can hide their trades. Thus, the degree of informational efficiency (larger amount of information in prices) is linked to the degree of operational efficiency (larger amount of liquidity in the market).

Policy implications

- The link between the first two types of efficiency raises concern about attempts to impose transparency on markets (Zorn 2004). Sophisticated investors produce private information on an asset in order to trade on it and make a profit. This information is revealed to the market through the trades and quotes of the investors. This helps make the market more informationally efficient as defined above. Suppose policy-makers cause an operational change by forcing investors to reveal price quotes or trades that they wish to keep private. The investors will then have less incentive to produce that private information. This means that the informational efficiency of the market will decline. This, in turn, means a decline in the market's liquidity, which would hurt non-informed (small) liquidity-based traders.
- There are global implications to this research as well. Barriers to transferring capital across borders can exist because of either formal capital controls or microstructure issues, such as lack of available liquidity, concerns about asymmetric information, etc. Differences in operational and informational efficiency may also cause traders to choose alternative markets in different countries in which to conduct the same trade.

Allocative Efficiency

A market is allocatively efficient when the marginal rate of return (adjusted for risk) is equal for all borrowers and savers. This implies that investors provide funds for projects that have the highest net present value and that no "good" investment projects go unfunded.[12] The concept of allocative efficiency is related to the large body of literature on the investment choices of firms. It is also related to the consumption/saving decisions of consumers. In general, to evaluate whether a market is allocatively

10. An example using the standard Gordon growth model of stock prices illustrates this point. Suppose a stock has a dividend of $1 per year that is expected to grow by 3 per cent per year. Also suppose that the required rate of return on the stock is 5 per cent per year. Under these assumptions, the price of the stock would be $50. Now suppose that a market friction is eliminated, causing the required rate of return of the stock to decline by 25 basis points (to 4.75 per cent per year). In this case, the price of the stock would increase to $57.14.
11. For a good overview of the operational efficiency of the clearing and settlements system, see McPhail (2003).
12. This definition is known to most economists as "Pareto optimality."

efficient requires a very sophisticated model of the economy.

The finance literature is, in general, concerned with a different set of questions. However, an important and very recent strand in the literature looks at the role played by informational and operational efficiency in allocative efficiency. For example, some papers look at how the amount of private information in a market affects the equilibrium required rate of return in the market (Easley, Hvidkjaer, and O'Hara 2002). If investors fear that certain more sophisticated investors possess information or superior knowledge about the asset (and that this information is not currently priced in), then they will demand a higher rate of return on the asset. Another part of the literature looks at the role of liquidity in equilibrium rates of return (Pástor and Stambaugh 2003). It is safe to say that the literature has not sorted out the separate roles played by information and liquidity in asset prices. It is clear, however, that these microstructure phenomena have an effect on equilibrium rates of return. Hence, it is safe to say that microstructure finance no longer provides only "small answers to small questions," which was a common perception of the early literature.

Thus, the amount of allocative efficiency in the market can be viewed as depending on the degree of informational and operational efficiency.[13] Prices will allocate resources in an optimal manner to the degree that they correctly incorporate information about an asset's fundamental value.

Conclusions

Research at the Bank has so far focused on the informational and operational aspects of efficiency in various Canadian capital markets. As noted above, improving informational and operational efficiency can significantly affect asset prices. Thus, changing these aspects via an exogenous policy shock could lead to significant effects on the required rates of return for Canadian corporations and, in turn, change the way funds are allocated in the market. Small policy changes imposed on financial market structure could thus potentially have large effects on real activity. Such policy directives therefore require a great deal of analysis before implementation.

13. Indeed, there are different definitions of allocative efficiency, depending on the information set used to measure the equilibrium outcomes.

References

Albuquerque, R., G.H. Bauer, and M. Schneider. 2004. "Characterizing Asymmetric Information in International Equity Markets." Working Paper, William E. Simon Graduate School of Business Administration, University of Rochester.

Bauer, G.H. and C. Vega. 2004. "Monetary Policy, Private Information, and International Stock Markets." *Bank of Canada Financial System Review* (this issue).

D'Souza, C. 2002. "Canadian Foreign Exchange Market Liquidity and Exchange Rate Dynamics." *Bank of Canada Financial System Review* (December): 59–61.

Easley, D., S. Hvidkjaer, and M. O'Hara. 2002. "Is Information Risk a Determinant of Asset Returns?" *The Journal of Finance* 47: 2185–2221.

Hendry, S. and M. King. 2004. "The Efficiency of Canadian Capital Markets: Some Bank of Canada Research." *Bank of Canada Review* (Summer): 5–17.

Kennedy, S. 2004. "Canada's Capital Markets: How do they Measure Up?" *Bank of Canada Review* (Summer): 33–40.

King, M. R. and M. Padalko. 2004. "Pre-Bid Run-Ups Ahead of Canadian Takeovers: How Big Is the Problem?" *Bank of Canada Financial System Review* (this issue).

McPhail, K. 2003. "Managing Operational Risk in Clearing and Settlement Systems." *Bank of Canada Financial System Review* (June): 79–81.

Pástor, L. and R.F. Stambaugh. 2003. "Liquidity Risk and Expected Stock Returns." *Journal of Political Economy* 111: 642–85.

Zorn, L. 2004. "Bank of Canada Workshop on Regulation, Transparency, and the Quality of Fixed-Income Markets." *Bank of Canada Financial System Review* (June): 39–44.