

Stock Price Formation when Information about Value is Costly

White paper

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Preface: Stock prices are not efficient in the sense that they always are the best possible estimate about company value. If that was true nobody would care to make costly analysis trying to determine the fundamental value of the company and if nobody did that then surely the stock would not be priced at all but would drift completely arbitrarily without any relation to its fundamental value. We know neither of these two scenarios is true. The stock price that can be observed in the stock market is not an accurate measurement of the firm's fundamental value nor is it completely unrelated to this value. This white paper presents a simple graphical theory to explain how stock prices are formed when information about their value is costly.¹

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¹ This document is based on Appendix 5 in Mathiesen's Ph.D. dissertation (Mathiesen [2002]).

1 Introduction

The classic financial textbook models on capital markets, such as, the perfect capital market model or the capital asset pricing model all assume that the cost of obtaining and analyzing information about value is zero.² This assumption greatly simplifies the models because it implies that all investors have perfect information and therefore are equally well informed about the true value of any firm. The following quote from Grossman and Stiglitz [1976, page 248] is telling: “Efficient markets theorists state that costless information is a sufficient condition for prices to fully reflect all available information (Fama [1970, page 387]). They are not aware that it is a necessary condition as well. But this is a *reduction ad absurdum*, since prices are important only when information is costly (see Friedrich A. Hayek [1945] and Grossman [1977a].)”.³ By arguing the opposite it is easy to see that the classic market efficiency models need to assume that the cost of information is zero. Suppose that the cost of obtaining and analyzing information about stock value is significant. In this case the stock prices are unable to fully reflect all available information. This is so because, if the stock price already reflects all available information, there would be no trading opportunities and therefore no way to cover the cost of obtaining information about stock value. As a result, the market would not have any knowledgeable investors and this is a *reduction ad absurdum*, since the stock price in such a market will move completely randomly and independent of any information about value.

The securities markets have known for centuries that it is costly to gather information about firms and their financial potential, and subsequently to analyze this information to produce estimates of fundamental corporate value.⁴ It is therefore regrettable that the classic capital market models rely on the assumption that information is costless. Grossman and Stiglitz [1976, 1980] remedy this problem by offering an alternative theory of asset pricing explicitly assuming that information about value is costly. The primary contribution of the current white paper is to present many of Grossman and Stiglitz’s ideas by using simple graphics instead of complicated mathematics. Very few have read Grossman and Stiglitz [1976, 1980] simply because the mathematics in these papers is a show stopper for most people. This is a shame because these papers offer important contributions for our understanding of the price formation in stock markets. Figure 1 below provides a graphical description of their arguments that is easier to comprehend. The remaining text is dedicated to explain the details of the theory behind this figure.

² The capital asset pricing model is derived at this [web address](http://e.viaminvest.com) (see, <http://e.viaminvest.com>). The perfect capital market model by Irvin Fisher [1930] can be found in Copeland and Weston [1988, Chapter 1] or alternatively at this [web address](http://e.viaminvest.com) (see, <http://e.viaminvest.com>).

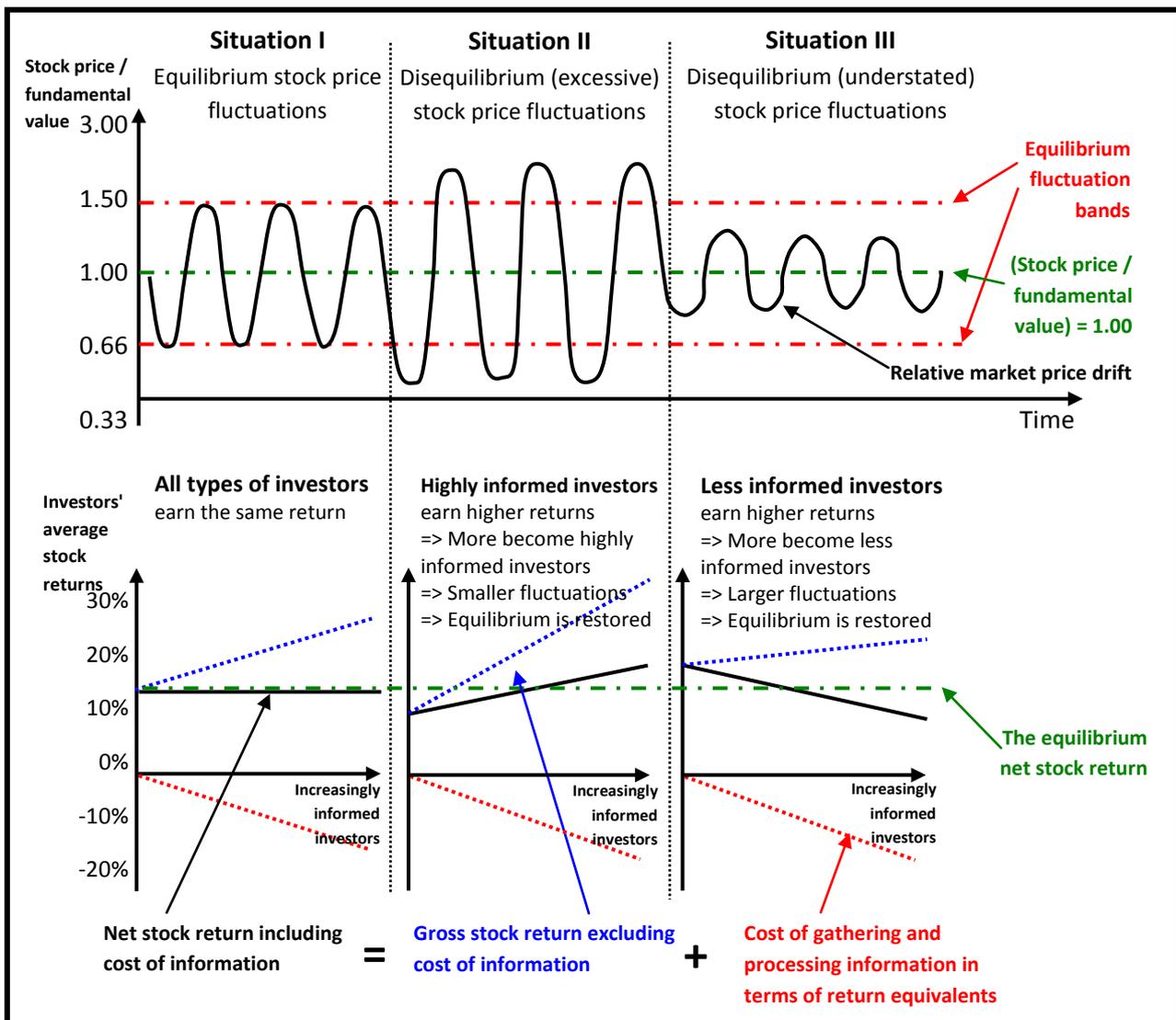
³ To be sure, Joseph Eugene Stiglitz (born February 9, 1943) is an American economist and a professor at Columbia University. He is a recipient of the John Bates Clark Medal (1979) and the Nobel Memorial Prize in Economic Sciences (2001).

⁴ Such work is typically the business of highly specialized and skilled value analysts. These analysts would not do all this work if it could not increase their ability to sell dear and buy cheap the stocks that they follow. This kind of work is commonly referred to as ‘fundamental value analysis’ and the technical details of these analyses can be found at the following [web address](http://e.viaminvest.com) (see, <http://e.viaminvest.com>).

2 The Theory - Equilibrium and Disequilibrium

Figure 1 essentially shows that the stock price of a firm needs to fluctuate around its fundamental value, and that the equilibrium velocity of fluctuation is the one that equals the net stock returns of all investor types ranging from the uninformed to the highly knowledgeable. The upper half of Figure 1 depicts these fluctuations in a diagram with time on the horizontal axis and the ratio of stock price to fundamental value on the vertical axis. Such a diagram can in principle be drawn for any stock by investors that are highly informed about the fundamental stock value. The diagram shows three basic situations. In Situation I the stock price is fluctuating at a velocity that equates the net stock return for all investors ranging from the uninformed to the highly informed. In Situation II the stock price is fluctuating excessively making the net returns of the more informed investors higher than the net returns of the less informed investors. Finally, in Situation III the stock price fluctuates so moderately that the net return of the less informed investors are higher than the net returns of the more informed investors.

Figure 1: Stock price formation when information about value is costly



It should be mentioned that the first version of this figure was made by Mathiesen [1996, chapter 4]. Furthermore, many of the ideas in this figure are consistent with those presented by Grossman and Stiglitz [1976, 1980], and Cornell and Roll [1981].⁵

Situation I: The equilibrium velocity of stock price fluctuations is realized in Situation I because it ensures that all types of investors ranging from the uninformed to the highly informed earn the same net stock return. How this works can be seen from the diagram to the left in the lower half of Figure 1. The vertical axis of this diagram shows the investors' average stock return, whereas the horizontal axis maps a continuum of investor types with increasingly knowledgeable investors.⁶ The diagram contains three lines. One is the decreasing red line showing how increasingly informed investors spend more money gathering and analyzing information. The second line is the increasing blue line showing how increasingly informed investors are able to earn an increasing gross return on their investments. Finally, the third line is the flat black line showing the different investors' net stock return measured as the gross stock return plus the cost of gathering and analyzing information. In this equilibrium situation all investor types earn the same, because the higher gross return from being more informed is exactly offset by the higher costs of gathering and analyzing information. Furthermore, since all investor types are doing equally well they have no incentives to change their investment strategy.

Situation II: To be sure, Situation I is an equilibrium situation because there are economic forces that automatically restore the equilibrium in the case that it is disrupted by external shocks of some kind. This is demonstrated by Situation II and Situation III in Figure 1. In Situation II the stock price fluctuations exceed the equilibrium fluctuation bands marked by the two red lines in the diagram in the upper half of the figure. The external shock provoking Situation II could, for instance, be an economic crisis that terminates numerous of asset management companies and that consequently reduces the number of value investors in the market for that stock. With fewer of the highly informed investors in the market the stock price begins to fluctuate more around its fundamental value. Larger fluctuations create better investment opportunities for the remaining highly informed investors to earn higher gross returns, whereas the cost of gathering and analyzing information should be more or less unaffected. These effects are shown in the diagram in the middle of the lower half of Figure 1. In particular, the gross return depicted by the blue line is steeper than the similar graph in the Situation I graph to the left, but the red line that depicts information costs remains equally steep. The result is that the more informed investors receive higher net stock returns than the less informed investors as shown by the increasing black line in the diagram in the middle of the lower half of Figure 1. This situation cannot persist, because as the market realizes that the knowledgeable investors earn more, some investors will start spending more money on gathering and analyzing information. Eventually this situation increases the number and the quality of the informed investors and this, in turn, causes the stock price to fluctuate less. As this happens the incentive to become more informed will gradually fall and the influx of more informed investors will slow down and finally stop when reaching the equilibrium level of stock price fluctuations.

⁵ An interactive version of the figure is also available at the following [web address](http://e.viaminvest.com) (see, <http://e.viaminvest.com>).

⁶ Grossman and Stiglitz [1976, 1980] do not assume a continuum of increasingly informed investors, but make the more simplifying assumption that either the investor is informed or the investor has no information apart from being able to observe the price. Consequently, in their model the cost of becoming informed is fixed. Either you pay 'x' to become informed or you pay nothing and stay uninformed.

Situation III: In Figure 1 Situation III shows the effect of an opposite shock, this time decreasing the level of stock price fluctuations to less than its equilibrium level. Such a shock could for instance be caused by the entrance of several highly informed investors from expanding asset management companies. The situation is illustrated in the upper diagram of Figure 1 where the stock price fluctuations are smaller than the equilibrium fluctuation band indicated by the two red lines. Small fluctuations create less investment opportunities for the highly informed to cover their costs of gathering and analyzing information. This can be seen from the diagram to the right in the lower part of Figure 1. In this diagram the blue line measuring the gross return from being an informed investor has decreased compared to the equilibrium situation. The cost of gathering and processing information (the red line) is unchanged compared to the equilibrium situation. The result is that the net returns from being less informed are higher than for those that are more informed as illustrated by the negatively sloped black line in Situation III. The market will eventually discover that it is more profitable to be uninformed rather than informed, and subsequently some of the informed investors either leave that market or simply stop spending money gathering knowledge about fundamental value. This situation in turn leads to more volatile fluctuations and the process continues until the equilibrium volatility is restored and all investor types make the same net income, thereby eliminating further incentives to switch investment strategy.

3 Information Distribution, Equilibrium Return and Theory Limitations

Information distribution: An important issue is the question of how information about value is spread from informed investors to uninformed. Grossman and Stiglitz [1980, page 393] describe it this way: “When informed individuals observe information that the return to a security is going to be high, they bid its price up, and conversely when they observe information that it is going to be low. Thus the price system makes publicly available the information obtained by informed individuals to the uninformed. In general, however, it does this imperfectly; this is perhaps lucky, for where it to do it perfectly, an equilibrium would not exist.” In terms of Figure 1 the informed investors start to sell when they observe that the stock price is higher than its fundamental value, thereby decreasing the stock price-to-value ratio. Conversely, when the stock price is observed to be lower than its fundamental value, the informed investors begin to buy the stock, thereby initiating an increase in the stock price-to-value ratio. These processes are imperfect because of the investors’ unequal knowledge and because the fundamental value of a stock is an uncertain and difficult variable to measure accurately.

The equilibrium net stock return: The price dynamics described in the previous paragraph should in the long-run be able to equate the net stock return of all categories of investors ranging from the uninformed to the most informed. Figure 1 refers to this common stock return as *the equilibrium net stock return* and it is depicted by the dotted horizontal line in the lower part of the figure. In this connection the particular mapping of the net stock return in the two disequilibrium situations should be noted. Specifically, in Situation II with excessive stock price fluctuations the highly informed investors earn higher net returns than the equilibrium net stock return whereas the less informed investors earn less. Furthermore, this picture is reversed in Situation III with the understated stock price fluctuations. In this situation the less informed investors earn higher net returns than the equilibrium net stock return and the highly informed earn less. Neither of these patterns is a coincidence but can be logically explained.

For instance, in Situation II the higher stock price fluctuations in this scenario imply better investment opportunities for the highly informed investors and the gross return should therefore be higher for these investors when compared to the gross returns they can earn in the equilibrium situation. Moreover, the aggregated gross return off all investors must be equal to the gross return on the stock and is as such independent of the velocity of the stock price fluctuations. Consequently, when the highly informed investors earn higher gross returns the less informed must earn less gross return in Situation II than they do in Situation I. This logic is shown explicitly in the lower part of Figure 1 where the gross return depicted by the blue line not only is steeper in Situation II but also starts from a lower level than in Situation I. Furthermore, since the completely uninformed investor located at the start point spends zero money on information the net return represented by the black line also need to be initiated from the same point in situation II that lies below the equilibrium net stock return. The net stock return in situation II must also be increasing for increasingly informed investors, since the gross return increases faster for more informed investors in Situation II than in Situation I and because the cost of information increases at the same rate in both Situations I and II. Finally, the net stock return of the most informed investors in Situation II must be higher than the equilibrium net stock return because the most informed investors earn higher gross returns in Situation II than in Situation I and because the cost of information is the same for these investors in both Situations I and II. It has hereby been demonstrated that the net return in Situation II needs to be below the

equilibrium net return for the less informed investors and above it for the highly informed. In a similar way it can be argued that the opposite is the case for Situation III, but these arguments are omitted.

Theory limitations: The theory depicted above is believed to do better than the classic capital market models in terms of explaining how stock prices are created but it still has its limitations. In particular, it predicts that all market participants from the uninformed to the most informed in the long-term earn the same net return or the equilibrium net stock return. Is this realistic? At best it is a fairly accurate description of the long-term net earnings for most of the stock market participants. However, it is certainly not the whole truth. There are at least two important types of market participants that should be able to earn substantially more than this equilibrium net stock return. One is illegal insider traders and the other type is traders with proprietary investment systems. The implications of illegal insider trading on the stock price formation are discussed in detail in the next section. Therefore, here it suffices to stress that illegal insider traders are able to make abnormal net returns because they for some reason have access to non-public information that are known to have a substantial and predictable impact on prices when it is published. The insiders can take advantage of their knowledge by trading the stocks before this important information is published to the stock market. With regard to traders with proprietary investment systems these are investment managers that have developed proprietary investment systems that enable them to earn abnormal net returns. This is comparable to companies in other industries that have developed and subsequently taken a patent on something that enable them to make excess profits in their industry as long as their patent is running. However, investment managers cannot use patents to protect their proprietary investment systems because it is impossible to enforce such patents. Instead, they keep their proprietary systems undisclosed for as long as possible. Eventually, the information about the proprietary systems will be lost to the public either because it is reinvented by others or perhaps because the management company is losing employees that start up elsewhere with the same systems.

4 Regulation of Stock Markets and Efficiency

All markets need some degree of regulation to protect and promote the efficient trade execution and the stock market is no exception. Apart from the most basic regulation such as property rights and trading rules stock markets also needs other types of regulation. The following considers three other types of regulation in particular 1) disclosure regulation, 2) insider regulation and 3) systems to secure trading anonymity. These three pieces of regulation are discussed in relation to their consequences for the theory on stock price formation that is depicted in Figure 1.

Disclosure regulation

Public stock markets are most dependent on tough disclosure regulation that requires a timely flow of information that is important for the investors' ability to estimate the fundamental value of the firms. Such disclosure laws are largely responsible for how costly it is to obtain credible estimates of fundamental value. In particular, more requiring disclosure laws reduce the cost of obtaining information about value from the investors' point of view but also add cost from the companies' point of view. More requiring disclosure laws may in turn lead to more stable stock prices because they will not have to fluctuate as much around their fundamental value in order to create the necessary opportunities for the highly informed investors to cover their cost of gathering and analyzing information. In this regard it is interesting to note that once the assumption about costless information is relaxed and replaced by the more realistic assumption of costly information then the discussion about capital market efficiency becomes very much a matter of the laws and institutions that are needed to sustain the functioning of these markets.

Regulation of insider trading

Another important issue that should be considered in a theory of stock price formation is the question of insider trading. To be sure, insider trading is typically defined as a situation where a person possesses material non-public information about the value of a security and subsequently is trading that security to his own benefit without first disclosing the inside information to the market. Whether insider trading is illegal or not depends on the situation. A classic example of illegal insider trading is the CEO of a publicly traded company that sells his shares in the company just before he announces a large and unexpected loss in the company. For an example of perfectly legal insider trading consider an investment manager that estimates the value of a stock using publicly available sources of information and subsequently uses this non-public estimate of value to make abnormal gross returns in the stock market. The distinguishing features between the two situations is that the CEO acquires the insider information at no effort and therefore does not add any new value to the stock market as a price maker that the market could not have figured out for itself when the insider information is published whereas the investment manager creates new insider information from publicly available sources of information by costly and time consuming analysis about fundamental value and therefore contribute to the vital price making processes in the stock market. In the following we shall refer to the former situation as either *effortless insider trading* or *illegal insider trading* as the illegal forms of insider trading always are characterized by being effortless. It is argued below that for stock markets to function effectively as a pricing mechanism it is essential that the effortless kind of insider trading is made illegal and prevented from happening at any substantial scale.

To be sure, insider trading is irrelevant with regard to the classic capital pricing models because they assume that all relevant information about value can be obtained at no costs by all traders. As a result, everybody knows the fundamental value at all times and for that reason insider trading is impossible. The situation is quite different with regard to the more realistic stock formation theory in Figure 1 where knowledge about fundamental value is costly and unevenly distributed among traders. However, for the stock market to be well functioning as a pricing mechanism it is important that the effortless kind of insider trading as defined above is outlawed and prevented from occurring at any significant scale. The problem with effortless insider trading is that it enables some investors to earn net returns that are far higher than the equilibrium net stock return that is implied by the theory in Figure 1 and shown by the horizontal black line in Situation I in the lower part of the figure. This is possible because effortless insider information, such as prior knowledge about mergers, harvest statistics, or product innovations, is by definition acquired at zero costs and has profound implications for the assessment of the fundamental value when published to all the market participants. The existence of massive effortless insider trading would therefore disrupt the ideal functioning of the stock market that can only be highly efficient if it provides equal opportunities for all kind of investors to make money. Specifically, firms whose stock markets are characterized by massive effortless insider trading should be expected to face higher cost of capital than firms whose stock markets do not suffer from massive illegal insider trading. To see this, note that the effortless insider traders are making their gains on behalf of all other investors in the stock market. These other investors would therefore require higher average stock returns from firms plagued by illegal insider trading to compensate them for their extraordinary losses from trades with the illegal insider traders.

It is argued that increasing effortless insider trading causes the firm's cost of capital to increase. To repeat, the reason that ordinary investors should demand higher returns from stocks that are plagued by effortless insider trading is simply to compensate them from the losses that result from the illegal insider trading. The efficiency of the stock market as a mechanism that allocates capital to the most profitable activities is therefore dependent on legislation and institutions that are able to minimize the occurrence of effortless insider trading. Unfortunately, there is evidence that such insider trading is widespread even in modern countries like USA that clearly outlaws most forms of effortless trading.⁷ In particular, several studies have documented that much of the adjustment in the stock prices regarding important value related announcement occur prior to the official announcement date.⁸ For instance, Keown and Pinkerton [1981] analyzing merger announcements in a sample of 194 US firms found that about half of the stock price adjustment happens before the announcement. They also document significant increases in the trading volumes in the three weeks prior to the merger announcements. They furthermore checked the records of the Securities and Exchange Commission to see whether any of the firms' insiders as defined by law had been involved in any of the trading prior to the public announcement. They found that this was not the case. In other words, although the occurrence of insider trading is evident, it appears to be done in ways that are non-obvious or difficult to detect by the authorities. For instance, it could be done by insiders that are using third parties to do the trades or perhaps the information is acquired by third parties by outright

⁷ Specifically, Rule 10b-5 of the US Securities Exchange Act of 1934 outlaws trades on nonpublic information by anyone who possesses such information whether being an insider in the legal sense or not. The US Securities and Exchange Commission defines an insider in the legal sense as a member of the board of directors, corporate officers, and beneficial owners of more than 10% of any class of stock.

⁸ Some references are: Ball and Brown [1968], Grinblatt, Masulis, and Titman [1984], Keown and Pinkerton [1981], Kraus and Stoll [1972], Patell and Wolfson [1984], Rendleman, Jones and Latané [1982], and Watts [1978].

theft or by use of bribes. In any case it would be difficult, if not impossible, to convict such insiders in court for violating the insider law.

It could be argued that illegal insider trading is beneficial in the sense that it enables a faster adjustment of stock prices to changes in fundamental values since the stock prices do adjust in the weeks and days prior to important news announcements. However, such arguments are doubtful for several reasons. One reason is that insider trading is also associated with an incentive for the insiders to delay the publication of the insider information until the insider trading has taken place. In the case of a CEO insider this is clearly a possibility but it is also a possibility for high level government officials at statistical agencies. Another reason is that even if illegal insider trading did imply that the market price would adjust faster than in a situation with no illegal insider trading the few days or weeks we are talking about would not be enough to have any important beneficial consequences for the long-run ability of the capital market to efficiently allocate capital to the most profitable activities. Consequently, the harm from illegal insider trading done by increasing the firm's cost of capital is far more permanent and profound than the possible gains.

Securing trading anonymity

An important implication of costly information is that many stock market transactions are far from being completely random. This is so because, when some investors are better informed than others about the fundamental stock value, they will not transact at random but rather restrict sales to periods of high stock price-to-value ratios, whereas buys are restricted to periods of low stock price-to-value ratios. These non-random transactions should be sizeable because although the highly informed investors may work independently they should tend to arrive at more or less the same conclusions at the same time about fundamental value, and their market transactions should therefore be fairly synchronized. The uninformed investors would in principle transact randomly because they do not know when the stock price is high or low compared to the fundamental value. However, in reality many transactions by the uninformed investors are not random simply because many trades have to be made with the highly informed investors that do not trade at random. The only truly random transactions are trades from one uninformed investor to another uninformed investor. Such transactions are random in the sense that they enable the uninformed investors to earn the average market return. This situation is unlike transactions between informed and uninformed investors where the informed investor earns gross returns that are higher than the market average at the expense of the uninformed investor. These observations are quite important because they imply that a well functioning stock market needs to secure the anonymity of the actual traders for at least during the time of the trade. This is so because, if the uninformed traders had information about the types of the other traders, they would not make any deals with the informed investors since such deals on average would be less profitable than deals with other uninformed traders. In such hypothetical circumstances it would be impossible for the informed investors to cover the cost of being informed and the stock price would therefore not be very representative of fundamental value since such a stock market would lack an adequate number of informed investors. Fortunately, this is not the case in modern stock markets where most trades are very anonymous and mediated by banks and securities companies that secure the proper transfer of money and ownership most often by the use of purely automated computer systems.

5 Concluding Remarks

The classic theories on asset pricing all assume that the cost of gathering and analyzing information about fundamental value is costless. Such an environment leads to perfectly priced assets that always reflect their true fundamental value and the scope for profitable asset trading is therefore zero. In other words, no investor has any opportunity to 'buy cheap and sell dear' because the price is already reflecting the fundamental value. Grossman and Stiglitz [1976, 1980] present an alternative capital market theory that explicitly assumes that the cost of gathering and analyzing information about fundamental value is costly. This new and more realistic assumption dramatically alters the perception of how the stock market functions. However, Grossman and Stiglitz' work is highly abstract and mathematical and the many important implications of their theory are therefore not accessible for most people. The contribution of this white paper is foremost that it presents many of the ideas made by Grossman and Stiglitz in terms of straightforward graphics. It also adds to the realism of the work by Grossman and Stiglitz by assuming a continuum of increasingly informed investors instead of assuming (as they do) that investors are either not knowledgeable at all or that they are equally highly informed about value. The graphical presentation in this white paper, moreover, makes it clear that the efficiency of the stock markets very much is a question of drafting adequate regulation and having the right institutions, such as the disclosure laws and the laws that bar trade on some kinds of insider information. The assumptions of the classic capital market theory do not leave much room for the role of institutions in facilitating trade, although they obviously are very important for the well functioning of real stock markets.

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